PUMP, PUMP DEVICE, DISPENSING HEAD, DISPENSING HEAD ARRAY AND DISPENSING DEVICE

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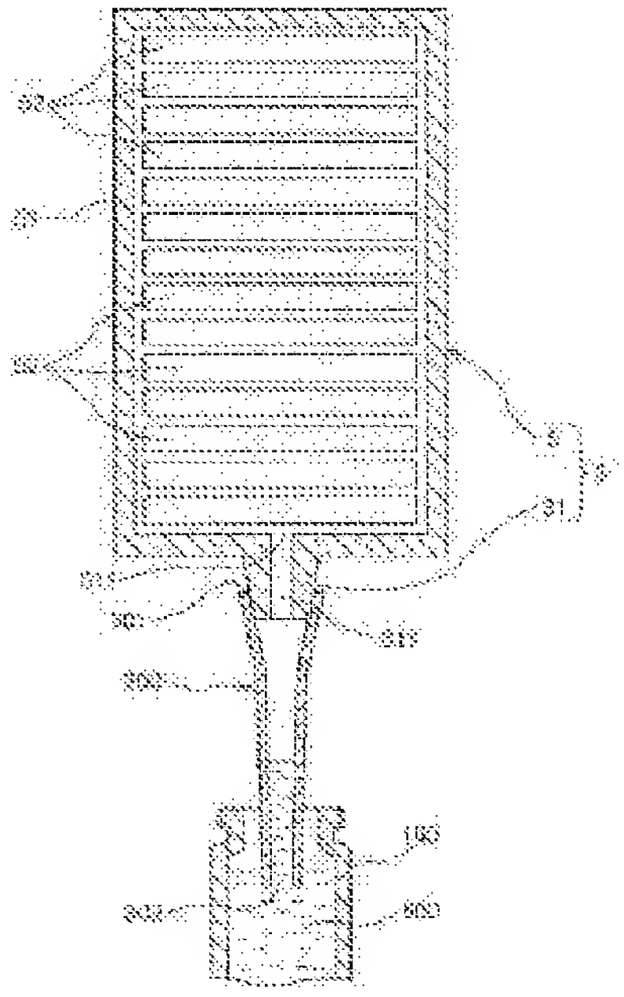
PROBLEM TO BE SOLVED: To provide a pump, a pump device, a dispensing head, a dispensing head array and a dispensing device capable of sucking and discharging a fluid with a simple structure and with high accuracy.



* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]A pump characterized for a fluid by inhalation / carrying out the regurgitation from said outflow/entrance by having the following, carrying out release of energization to said energized part, or energization, and changing volume of said volume variable member.
Housing in which an outflow / outflow which carries out ON / entrance was formed for a fluid.
At least one volume variable member which comprised a substance from which volume changes by being installed in said housing and impressing voltage or a magnetic field.
An energized part which impresses voltage or a magnetic field to said volume variable member by energization.

[Claim 2]The pump according to claim 1 in which said fluid is a working fluid.
[Claim 3]The pump according to claim 1 or 2 with which said volume variable member comprises piezoelectric material or a magnetostrictive material.
[Claim 4]The pump according to any one of claims 1 to 3 which has said two or more volume variable members.
[Claim 5]The pump according to claim 4 which said two or more volume variable members make tabular, respectively, leaves a crevice in the thickness direction, and is arranged in piles.
[Claim 6]Said energized part is individually provided to said each volume variable member, respectively, and it is the pump according to claim 4 or 5 which can impress voltage or a magnetic field independently, respectively to said each volume variable member.
[Claim 7]The pump according to any one of claims 1 to 6 with which said housing is making cylindrical shape mostly.
[Claim 8]The pump according to any one of claims 1 to 6 which is making shape with said flat housing.
[Claim 9]A pumping plant comprising:
The pump according to any one of claims 1 to 8.
A pump control means which controls an operation of said pump.

[Claim 10]By adjusting energizing voltage to said energized part, it is the pumping plant according to claim 9 which can adjust inhalation/discharge quantity of a fluid.
[Claim 11]Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, It is the pumping plant according to claim 9 or 10 which can adjust inhalation/discharge quantity of a fluid by adjusting the number of said energized part which can impress voltage or a magnetic field independently to said each volume variable member, respectively, and carries out release of energization or energization.
[Claim 12]Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, The pumping plant according to any one of claims 9 to 11 which sets a time lag to each energized part, and performs release of energization or energization when voltage or a magnetic field can be independently impressed to said

each volume variable member, respectively and release of energization or energization is carried out to said two or more energized parts.
[Claim 13]By adjusting said time lag, it is the pumping plant according to claim 12 which can adjust inhalation/discharge velocity of a fluid.
[Claim 14]A distributive-pouring head which is provided with the following and characterized for a fluid by inhalation / carrying out the regurgitation and pouring a fluid distributively from a tip opening of said nozzle by the operation of said pump.
The pump according to any one of claims 1 to 8.
It is a nozzle applied part which can equip with a nozzle so that it may be open for free passage at said outflow/entrance of said pump.

[Claim 15]A distributive-pouring head array which installs two or more distributive-pouring heads according to claim 14 side by side, and is characterized by things.
[Claim 16]The distributive-pouring head array according to claim 15 which said each distributive-pouring head is making flat shape, and installs said two or more distributive-pouring heads in the thickness direction side by side.
[Claim 17]A distributive-pouring device having at least one of the pumping plants according to any one of claims 9 to 13 as a suction means.
[Claim 18]A distributive-pouring device provided with at least one distributive-pouring head according to claim 14.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to a pump, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device.
[0002]
[Description of the Prior Art]For example, the distributive-pouring device which does classification of a little fluids, such as a sample and a reagent, dilution, mixing, dropping work, etc. is known. This distributive-pouring device is used, for example in the field of a clinical laboratory test, the field of a fundamental research, etc.
[0003]The distributive-pouring head in the conventional distributive-pouring device is provided with the syringe which has a piston which slides within a tube-like object and this tube-like object, the piston moving mechanism to which a piston is moved, and the nozzle which is open for free passage in a syringe. And inhalation and the regurgitation carry out a fluid from the tip opening of a nozzle by moving a piston and changing the pressure in a syringe according to a piston moving mechanism.
[0004]However, in the conventional distributive-pouring head, since the mechanical piston moving mechanism which used the feed screw etc., for example was needed, there was a problem that structure was complicated and a manufacturing cost was high.
[0005]It was difficult to improve the accuracy of the amount of distributive pouring by the mechanical backlash of a piston moving mechanism, a backlash, etc., since the precision improvement of the position control of a piston is difficult. In particular, a little fluids were not able to be poured distributively in high accuracy.
[0006]Since a piston moving mechanism was what performs mechanical operation, it was comparatively apt to cause failure and inferior also to endurance.
[0007]

[Problem(s) to be Solved by the Invention]The purpose of this invention is an easy structure and there is in providing the pump, the pumping plant, distributive-pouring head and distributive-pouring head array which can perform inhalation and the regurgitation of a fluid in high accuracy, and a distributive-pouring device.

[0008]

[Means for Solving the Problem]Such a purpose is attained by this invention of following the (1) - (18).

[0009](1) By at least one volume variable member which comprised a substance from which volume changes by installing a fluid in housing in which an outflow / outflow which carries out ON / entrance was formed, and said housing, and impressing voltage or a magnetic field, and energization. A pump characterized for a fluid by inhalation / carrying out the regurgitation from said outflow/entrance by having an energized part which impresses voltage or a magnetic field to said volume variable member, carrying out release of energization to said energized part, or energization, and changing volume of said volume variable member.

[0010](2) A pump given in the above (1) in which said fluid is a working fluid.

[0011](3) A pump the above (1) by which said volume variable member is constituted from piezoelectric material or a magnetostrictive material, or given in (2).

[0012](4) A pump the above (1) which has said two or more volume variable members thru/or given in either of (3).

[0013](5) A pump given in the above (4) which said two or more volume variable members make tabular, respectively, leaves a crevice in the thickness direction, and is arranged in piles.

[0014](6) Said energized part is individually provided to said each volume variable member, respectively, and it is a pump the above (4) which can impress voltage or a magnetic field independently, respectively, or given in (5) to said each volume variable member.

[0015](7) A pump the above (1) for which said housing is making cylindrical shape mostly thru/or given in either of (6).

[0016](8) A pump the above (1) which is making shape with said flat housing thru/or given in either of (6).

[0017](9) A pumping plant having a pump of a statement, and a pump control means which controls an operation of said pump in the above (1) thru/or either of (8).

[0018](10) By adjusting energizing voltage to said energized part, it is a pumping plant given in the above (9) which can adjust inhalation/discharge quantity of a fluid.

[0019](11) Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, A pumping plant of the above (9) which can adjust inhalation/discharge quantity of a fluid or a statement to (10) by what the number of said energized part which can impress voltage or a magnetic field

independently to said each volume variable member, respectively, and carries out release of energization or energization is adjusted for.

[0020](12) Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, A pumping plant the above (9) which sets a time lag to each energized part, and performs release of energization or energization when voltage or a magnetic field can be independently impressed to said each volume variable member, respectively and release of energization or energization is carried out to said two or more energized parts thru/or given in either of (11).

[0021](13) By adjusting said time lag, it is a pumping plant given in the above (12) which can adjust inhalation/discharge velocity of a fluid.

[0022](14) Have a nozzle applied part which can equip with a nozzle so that it may be open for free passage at said outflow/entrance of a pump the above (1) thru/or given in either of (8), and said pump, and by the operation of said pump. A distributive-pouring head characterized for a fluid by inhalation / carrying out the regurgitation and pouring a fluid distributively from a tip opening of said nozzle.

[0023](15) A distributive-pouring head array which installs two or more distributive-pouring heads of a statement in the above (14) side by side, and is characterized by things.

[0024](16) A distributive-pouring head array given in the above (15) which said each distributive-pouring head is making flat shape, and installs said two or more distributive-pouring heads in the thickness direction side by side.

[0025](17) A distributive-pouring device equipping the above (9) thru/or either of (13) with a pumping plant of a statement at least one as a suction means.

[0026](18) A distributive-pouring device equipping the above (14) with at least one distributive-pouring head of a statement.

[0027]

[Embodiment of the Invention]Hereafter, the pump of this invention, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device are explained in detail based on the suitable embodiment shown in an accompanying drawing.

[0028]The perspective view showing the volume variable member in the distributive-pouring head which shows drawing 2 drawing of longitudinal section showing the distributive-pouring head and nozzle in the distributive-pouring device which shows drawing 1 the perspective view in which drawing 1 shows the embodiment of the distributive-pouring device of this invention, and drawing 2, and drawing 3, and drawing 4 are the block diagrams of the distributive-pouring device shown in drawing 1.

[0029]As shown in drawing 1, the distributive-pouring device 1 is provided with the following.

Device main frame 2.

Distributive-pouring head 3.

Distributive-pouring head transportation device 4.
The distributive-pouring device 1 is provided with the pumping plant 6 of this invention as a suction means. This distributive-pouring device 1 is inhalation and a thing which carries out the regurgitation and does classification of the fluid 500, dilution, mixing, dropping work, etc. about the fluids 500, such as a drug solution and a sample, from the tip opening 302 of the nozzle 300 with which the distributive-pouring head 3 was equipped with the suction force which the pump 5 which the pumping plant 6 has generates.
[0030]The device main frame 2 has the stage 21. On the stage 21, the reagent vessel stowage 22, the reaction vessel stowage 23, and the nozzle stowage 24 are formed, respectively.In the reagent vessel stowage 22, can store two or more reagent vessels 100 which store a drug solution (charge), and to it in the reaction vessel stowage 23. Two or more reaction vessels 200 which store reaction mixture can be stored (charge), and two or more nozzles 300 for exchange can be stored in the nozzle stowage 24 (charge).
[0031]As shown in drawing 2, the distributive-pouring head 3 is provided with the following.
The pump 5 of this invention.
The nozzle applied part 31 which can equip with the nozzle 300.
Hereafter, the composition of this distributive-pouring head 3 is explained.
[0032]The pump 5 is provided with the following.
Housing 51.
Two or more volume variable members 52 installed in the housing 51.
The energized part 53 which impresses voltage to the volume variable member 52 by energization.

[0033]The housing 51 is a case which makes cylindrical shape mostly. This housing 51 comprises material with various metallic materials, ceramics, a hard resin material, etc. hard, for example, and has become a rigid body which is not expanded and contracted substantially.

[0034]The air (gas) as a working fluid flows into the pars basilaris ossis occipitalis of the housing 51, and the outflow entrance 511 which carries out ON is formed in it. The seal of the portions other than outflow entrance 511 of the housing 51 is carried out so that it may not let a fluid pass, and airtightness (fluid-tight nature) is secured.
[0035]The volume variable member [two or more (the composition of a graphic display 14 pieces)] 52 is installed in the building envelope of the housing 51. These volume variable members 52 are the same composition mutually, and are making disc-like, respectively.
[0036]The volume variable member 52 comprises a substance from which volume changes by impressing voltage (electric field). Especially as such a substance, although not limited, piezoelectric material, such as crystal (SiO_2), lithium niobate, barium titanate, lead titanate,

lead zirconate titanate (PZT), a lead metaniobate, and polyvinylidene fluoride (PVDF), is mentioned, for example.

[0037]As shown in drawing 3, to each volume variable member 52, the energized part 53 is formed individually, respectively. The energized part 53 comprises the laminated electrodes 531 and 532 and the leads (signal wire) 533 and 533 connected to the electrodes 531 and 532, respectively. The electrode 531 is contacted and formed in one field of the volume variable member 52, and the electrode 532 is contacted and formed in the field of another side of the volume variable member 52. The leads 533 and 533 are electrically connected to the pump drive circuit 12 provided outside, respectively. In drawing 2, the graphic display of the electrodes 531 and 532 and the lead 533 is omitted.

[0038]As shown in drawing 2, two or more disc-like members which consist of the volume variable member 52 and the electrodes 531 and 532 leave the crevice into which a fluid may invade, and are arranged mostly in piles at equal intervals in the thickness direction. By such arrangement, two or more volume variable members 52 can be efficiently arranged to the space in the housing 51, and it contributes to the miniaturization of the pump 5.

[0039]The supporting structure within the housing 51 of the disc-like member which consists of the volume variable member 52 and the electrodes 531 and 532 can be made into the supporting structure using the spacer which what kind of thing may be sufficient as, for example, is not illustrated. This supporting structure is the structure which can free modification which each volume variable member 52 mentions later.

[0040]As shown in drawing 4, it is connected to the control section (CPU) 11, and the pump drive circuit 12 is energized to the energized part 53 based on the control signal from the control section 11. The control section 11 controls the operation of the pump 5 like the after-mentioned based on the application program for controlling the pump 5 stored in the storage parts store 18, and the input data inputted from the input part 19. The pump control means 13 which controls the operation of the pump 5 comprises the control section 11, the pump drive circuit 12, the storage parts store 18, and the input part 19.

[0041]If it energizes to the energized part 53, the voltage (electric field) produced between the electrode 531 and the electrode 532 will be impressed to the volume variable member 52. According to the piezo-electric effect, it will elongate to the thickness direction and the volume variable member 52 will be contracted to a diametral direction, if voltage is impressed. And if impression of voltage is canceled, the volume variable member 52 will return to the original shape.

[0042]When the volume of the volume variable member 52 before and after such modification is measured, the volume of the volume variable member 52 in the state where voltage was impressed is slightly larger than the volume in the state where voltage is not impressed. That is, if the volume variable member 52 impresses voltage, volume will increase, and if

impression of voltage is canceled, volume will decrease.

[0043]Since the capacity of the left-behind space (space which is not occupied by volume variable member 52 grade) in the housing 51 will decrease if the volume of the volume variable member 52 increases, the air in the housing 51 flows out and it flows out from the entrance 511. On the contrary, since the capacity of the left-behind space in the housing 51 will increase if the volume of the volume variable member 52 decreases, air flows out and it flows in the housing 51 from the entrance 511. Thus, as for the pump 5, inhalation and the regurgitation carry out air from the outflow entrance 511.

[0044]The pumping plant 6 of this invention comprises such a pump 5 and the pump control means 13 (refer to drawing 4).

[0045]As shown in drawing 2, the nozzle applied part 31 is formed in the pump 5 bottom. The channel 311 which is open for free passage at the outflow entrance 511 is formed in the inside of the nozzle applied part 31. If the nozzle applied part 31 is equipped with the nozzle 300, the lumen of the nozzle 300 will flow out via the channel 311, and will be open for free passage at the entrance 511 (inside of the housing 51).

[0046]The portion by the side of the lower end of the nozzle applied part 31 is the tapered shape which an outer diameter dwindles toward down. When this tapered shape portion inserts without a crevice and fits in in the end face opening 301 of the nozzle 300, the nozzle 300 is fixed in airtight to the nozzle applied part 31, enabling free attachment and detachment. the nozzle 300 comprises various resin materials etc. preferably, for example -- being disposable (throwing away) -- it has become.

[0047]When pouring a different fluid distributively, contamination can be prevented by exchanging the nozzle 300. As for exchange of the nozzle 300, it is preferred that the nozzle replacement mechanism in which make it move to the nozzle stowage 24, and the distributive-pouring head 3 is not illustrated can perform now automatically.

[0048]It may be what it may be equipped with the nozzle 300 by screwing in this invention not only to composition like a graphic display but to the nozzle applied part 31, enabling free attachment and detachment, and the nozzle 300 cannot detach and attach to the distributive-pouring head 3.

[0049]As shown in drawing 1, the distributive-pouring head transportation device 4 is provided with the following.

The rising and falling mechanism 41 which supports the distributive-pouring head 3 which was explained above movable in the perpendicular direction (Z shaft orientations).

Y axial movement mechanism 42 which moves the rising and falling mechanism 41 horizontally (Y shaft orientations).

X axial movement mechanism 43 which moves Y axial movement mechanism 42 to a horizontal direction (X axial direction) vertical to a Y-axis.

By such composition, the distributive-pouring head transportation device 4 can move the distributive-pouring head 3 now in the direction of a three dimension on the stage 21.
[0050]The operation of the distributive-pouring head transportation device 4 is controlled by the control section 11 based on the application program for controlling the distributive-pouring head transportation device 4 stored in the storage parts store 18, and the input data inputted from the input part 19.
[0051]The rising and falling mechanism 41, Y axial movement mechanism 42, and X axial movement mechanism 43 can be used as the arbitrary mechanisms which the mechanism of what kind of structure may be sufficient as, for example, used a feed screw, a rack & pinion gear, a servo motor, a fluid pressure cylinder, etc.
[0052]Such a distributive-pouring device 1 does the distributive-pouring work of classification of the fluid 500, dilution, mixing, dropping, etc., moving the distributive-pouring head 3 between each reagent vessel 100 and each reaction vessel 200 by the operation of the distributive-pouring head transportation device 4.
[0053]Hereafter, the case where the fluid 500 in the reagent vessel 100 is classified for the operation of the distributive-pouring device 1 to the reaction vessel 200 is explained to an example.
[0054][1] The tip opening 302 of the nozzle 300 energizes on predetermined voltage to all the energized parts 53 by the state of being in the air, first. All the volume variable members 52 will be increased by volume by this.
[0055][2] Rank second, operate the distributive-pouring head transportation device 4, and move the distributive-pouring head 3 so that the tip opening 302 of the nozzle 300 may be located below the oil level of the fluid 500 in the reagent vessel 100.
[0056][3] In this state, if the energization to the energized part 53 is canceled, when the volume of the volume variable member 52 decreases, the air in the nozzle 300 will flow out, it will be inhaled in the housing 51 from the entrance 511, and the pressure in the nozzle 300 will decline. The fluid 500 is inhaled in the nozzle 300 from the tip opening 302 by this failure of pressure (refer to drawing 2).
[0057]At this time, the quantity of the fluid 500 inhaled in the nozzle 300 can be adjusted by adjusting the number of the energized part 53 which cancels energization. That is, when the number of the energized part 53 which cancels energization is one piece, the fluid 500 of the quantity corresponding to the amount of volume decreases of the one volume variable member 52 is inhaled in the nozzle 300. And the suction quantity of the fluid 500 will be the 2 and 3, ..., 14 times in general to the time of canceling energization of the one energized part 53 by considering it as two pieces, three pieces, ..., the 14 number of the energized part 53 which cancels energization. Thus, the suction quantity of the fluid 500 can be adjusted to 14 steps.
[0058]When it is a thing of the character in which volume does not return to the original size

(size of a standard) thoroughly at this time even if the volume variable member 52 makes impressed electromotive force zero, That is, when it is what has a hysteresis in the volume change of the volume variable member 52, after canceling the energization to the energized part 53, it is good also as performing control which impresses the voltage of an opposite direction to the energized part 53 so that the volume of the volume variable member 52 may return to the size of a standard. The fixed reference voltage in the energized part 53 is impressed in front of the above [1], Voltage higher than this can be impressed to the energized part 53 by [1], control of returning the impressed electromotive force to the energized part 53 to said reference voltage by [3] may be carried out, and influence of a hysteresis can be made small by this control. Higher-precision distributive pouring can be performed by performing these control [like]. In this specification, as mentioned above, after canceling the energization to the energized part 53, it is only called "release of energization" also including the case where the voltage of an opposite direction is impressed, and the case where the impressed electromotive force to the energized part 53 is returned to a certain fixed reference voltage.

[0059]In inhalation operation of such a fluid 500, if the energization to those energized parts 53 is simultaneously canceled when canceling the energization to two or more energized parts 53, the fluid 500 can be inhaled at high speed.

[0060]When canceling the energization to two or more energized parts 53, a time lag may be set to each energized part 53, and energization may be canceled. In this case, the suction speed of the fluid 500 can be adjusted by adjusting that time lag. That is, if the time lag is lengthened, suction speed can be made late, and suction speed can be made quick if the time lag is shortened.

[0061][4] If the fluid 500 is inhaled in the nozzle 300, the distributive-pouring head transportation device 4 will be operated, and the distributive-pouring head 3 will be moved to the position of the reaction vessel 200.

[0062][5] Rank second and energize on predetermined voltage again to the energized part 53 which canceled energization. The volume of the energized volume variable member 52 increases by this, the air in the housing 51 flows out, it flows out of the entrance 511, and the pressure in the nozzle 300 increases. The regurgitation (discharge) of the fluid 500 in the nozzle 300 is carried out from the tip opening 302 by this pressure increase. By making this breathed-out fluid 500 dropped at the reaction vessel 200 (fall), it gives into the reaction vessel 200. When adhered to the tip opening 302 neighborhood by the breathed-out fluid 500, It is better also as giving the breathed-out fluid 500 into the reaction vessel 200 than operate the distributive-pouring head transportation device 4 and contacting the tip part of the nozzle 300 into the wall of the reaction vessel 200, or the fluid in it.

[0063]In the case of such discharging of the fluid 500, the quantity of the fluid 500 which carries out the regurgitation can be adjusted by adjusting the number of the energized part 53

to energize like the time of the aforementioned inhalation operation.
[0064]If it energizes simultaneously to those energized parts 53 when energizing to two or more energized parts 53 in discharging of such a fluid 500, the regurgitation of the fluid 500 can be carried out at high speed. Depending on conditions, such as discharge quantity and an opening diameter of the tip opening 302, from the nozzle 300, as the fluid 500 is injected, the regurgitation can also be carried out.
[0065]When energizing to two or more energized parts 53 in discharging of the fluid 500, a time lag may be set and energized to each energized part 53. In this case, the discharge velocity of the fluid 500 can be adjusted by adjusting that time lag. That is, if the time lag is lengthened, discharge velocity can be made late, and discharge velocity can be made quick if the time lag is shortened.
[0066][6] By moving the distributive-pouring head 3 to other reaction vessels 200, and repeating operation of [5], the fluid 500 in the reagent vessel 100 is classifiable to each reaction vessel 200.
[0067]Thus, by the volume change of the volume variable member 52, in a fluid, the regurgitation is carried out and the pump 5 of this invention does not have [inhalation and] a mechanical flexible region. Therefore, since adverse effects, such as mechanical backlash and a backlash, are not received, suction quantity and discharge quantity are controllable by high accuracy (adjustment). In particular, in high accuracy, it can inhale and the regurgitation also of very little fluids can be carried out. Structure is easy and contributes also to reduction of a manufacturing cost. Since there is no flexible region, there is little fear of failure and it is excellent also in endurance.
[0068]In the distributive-pouring head 3 and the distributive-pouring device 1 of this invention provided with such a pump 5 (pumping plant 6), the amount of distributive pouring can be controlled by high accuracy (adjustment), and very little fluids can also be especially poured distributively in high accuracy.
[0069]In this embodiment, the energized part 53 is individually formed to two or more volume variable members 52, respectively, and when impression has become possible about voltage independently to each volume variable member 52, respectively, suction quantity and discharge quantity can be adjusted easily and with high precision. In this invention, when forming two or more volume variable members 52, the number in particular is not limited, for example, can be made into about 2-1000 pieces. By increasing the number of the volume variable member 52, suction quantity and discharge quantity can be adjusted more broadly from a minute amount to comparatively large quantity, and with high precision.
[0070]The setting number of the volume variable member 52 seems to have become settled in the value predetermined in suction quantity and discharge quantity in this invention at one piece. Even when the number of the volume variable members 52 is one, by adjusting the

energizing voltage to the energized part 53, the amount of volume changes of the volume variable member 52 can be adjusted, and, thereby, suction quantity and discharge quantity can also be adjusted.

[0071]Also when two or more volume variable members 52 are installed, it may be made to adjust the energizing voltage to the energized part 53. Thereby, suction quantity and discharge quantity can be adjusted with the more sufficient accuracy on a multi stage story.

[0072]Volume seems to decrease by impression of voltage in this invention to the embodiment and reverse which the volume variable member 52 mentioned above.

[0073]Although the target fluid 500 was poured distributively inhalation and by carrying out the regurgitation by using air (gas) as a working fluid in this embodiment, an insulating fluid may be sufficient as a working fluid in this invention. That is, it fills up with an insulating liquid in the housing 51, and the fluid 500 may be poured distributively via inhalation and the insulating liquid which carries out the regurgitation from the outflow entrance 511. When an insulating tunic is formed in the volume variable member 52 and the surface of the energized part 53, a fluid without insulation may be sufficient as a working fluid.

[0074]A volume variable member may be constituted from this invention by impression of a magnetic field by the substance from which volume changes (magnetostrictive effects). Especially as such a substance, although not limited, various magnetostrictive materials, such as a Tb-Dy-Fe alloy, a super magnetostriction material, etc. are mentioned, for example. In this case, as an energized part, the coil which impresses a magnetic field to this volume variable member by energization can be used, for example.

[0075]Drawing 5 is a perspective view showing the embodiment of the distributive-pouring head array of this invention. Hereafter, although the embodiment of the distributive-pouring head array of this invention is described with reference to this figure, it explains focusing on a point of difference with the embodiment mentioned above, and the same matter omits that explanation.

[0076]The distributive-pouring head array 7 shown in drawing 5 installs the distributive-pouring head [two or more (the composition of a graphic display 16 pieces)] 71 side by side. The distributive-pouring head 71 is the same as said distributive-pouring head 3 except the shape differing.

[0077]The housing 711 of the pump in the distributive-pouring head 71 is making flat rectangular parallelepiped shape. In the housing 711, the tabular volume variable member with long and slender plurality (large number) is arranged in piles.

[0078]The distributive-pouring head array 7 installs two or more such thin distributive-pouring heads 71 in the thickness direction side by side at a single tier. Since the mechanical driving source is an easy unnecessary structure, the pump of this invention has the high flexibility of shape. Therefore, such a thin distributive-pouring head 71 and the small distributive-pouring

head array 7 of an array pitch are easily realizable.
[0079]When pouring distributively to the microplate (multi-hole plate) which can be poured distributively at once to two or more places for example, by which many holes were formed in matrix form according to the distributive-pouring device provided with such a distributive-pouring head array 7, it can pour distributively promptly at very high efficiency.
[0080]Drawing 6 is drawing of longitudinal section showing other embodiments of the pump of this invention. Hereafter, although other embodiments of the pump of this invention are described with reference to this figure, it explains focusing on a point of difference with the embodiment mentioned above, and the same matter omits that explanation.
[0081]Pump 5' of this embodiment sends out a fluid toward right-hand side from the left-hand side in drawing 6. This pump 5' is applicable to other devices of various kinds of which send out not only a distributive-pouring device but a fluid.
[0082]Pump 5' is provided with the following.
It has the almost same composition as said pump 5, and is housing 51'.
Two or more volume variable members 52 installed in housing 51'.
The energized part 53 which impresses voltage to the volume variable member 52 by energization.

[0083]The input 512 where a fluid flows, and the tap hole 513 where a fluid flows out are established in housing 51', respectively. That is, in this embodiment, the input 512 and the tap hole 513 are separately formed in housing 51'. In the middle of the channel 14 connected to the input 512, the check valve (check valve) 16 is formed and the check valve (check valve) 17 is formed in the middle of the channel 15 connected to the tap hole 513.
[0084]If pump 5' operates like the above, pump 5' will inhale a fluid from the input 512, and will carry out the regurgitation of the fluid from the tap hole 513. Thereby, the fluid in the channel 14 and 15 can be sent out rightward in drawing 6.
[0085]That is, although said pumps 5 were inhalation and a thing which carries out the regurgitation about the target fluid 500 via the air (gas) which is a working fluid, directly, it inhales and breathes out and pump 5' of this embodiment sends out the target fluid.
[0086]As a fluid which pump 5' sends out, a fluid or a gas may be sufficient. In the case of a fluid, it is preferred that the insulating tunic is formed in the volume variable member 52 and the surface of the energized part 53.
[0087]Although there may not be the check valves 16 and 17, it is preferred that at least one side of the check valves 16 and 17 is provided.
[0088]As mentioned above, although the embodiment of the graphic display of the pump, the pumping plant, the distributive-pouring head, distributive-pouring head array, and distributive-pouring device of this invention was described, This invention is not limited to this and each

part which constitutes a pump, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device can be replaced by the thing of arbitrary composition of that the same function can be exhibited. Arbitrary structures may be added.

[0089]Although this invention is applicable from what has 1 time of comparatively large inhalation / discharge quantity to a very small quantity thing, 1 time of inhalation/discharge quantity are suitable for it to the minute amount thing which is about 1 nano liter -100 microliter especially.

[0090]The thing of what kind of shape, such as not only a tabular thing but rod form, block like shape, etc., may be sufficient as a volume variable member. What kind of thing may be sufficient also as the modification mode of a volume variable member when voltage or a magnetic field is impressed.

[0091]

[Effect of the Invention]As stated above, according to this invention, with high accuracy, the regurgitation can be carried out and inhalation and the regurgitation can carry out a fluid in inhalation and the accuracy in which a little fluids are also especially expensive.

[0092]The above-mentioned effect can be attained with an easy structure, and it contributes also to reduction of a manufacturing cost. There is little fear of failure and it is excellent also in endurance. Inhalation and the regurgitation can make a fluid high-speed.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention]This invention relates to a pump, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device.

[Translation done.]

PRIOR ART

[Description of the Prior Art]For example, the distributive-pouring device which does classification of a little fluids, such as a sample and a reagent, dilution, mixing, dropping work, etc. is known. This distributive-pouring device is used, for example in the field of a clinical laboratory test, the field of a fundamental research, etc.

[0003]The distributive-pouring head in the conventional distributive-pouring device is provided with the syringe which has a piston which slides within a tube-like object and this tube-like object, the piston moving mechanism to which a piston is moved, and the nozzle which is open for free passage in a syringe. And inhalation and the regurgitation carry out a fluid from the tip opening of a nozzle by moving a piston and changing the pressure in a syringe according to a piston moving mechanism.

[0004]However, in the conventional distributive-pouring head, since the mechanical piston moving mechanism which used the feed screw etc., for example was needed, there was a problem that structure was complicated and a manufacturing cost was high.

[0005]It was difficult to improve the accuracy of the amount of distributive pouring by the mechanical backlash of a piston moving mechanism, a backlash, etc., since the precision improvement of the position control of a piston is difficult. In particular, a little fluids were not able to be poured distributively in high accuracy.

[0006]Since a piston moving mechanism was what performs mechanical operation, it was comparatively apt to cause failure and inferior also to endurance.

[0007]

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Effect of the Invention]As stated above, according to this invention, with high accuracy, the regurgitation can be carried out and inhalation and the regurgitation can carry out a fluid in inhalation and the accuracy in which a little fluids are also especially expensive.
[0092]The above-mentioned effect can be attained with an easy structure, and it contributes also to reduction of a manufacturing cost. There is little fear of failure and it is excellent also in endurance. Inhalation and the regurgitation can make a fluid high-speed.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]The purpose of this invention is an easy structure and there is in providing the pump, the pumping plant, distributive-pouring head and distributive-pouring head array which can perform inhalation and the regurgitation of a fluid in high accuracy, and a distributive-pouring device.

[Translation done.]

MEANS

[Means for Solving the Problem]Such a purpose is attained by this invention of following the (1) - (18).

[0009](1) By at least one volume variable member which comprised a substance from which volume changes by installing a fluid in housing in which an outflow / outflow which carries out ON / entrance was formed, and said housing, and impressing voltage or a magnetic field, and energization. A pump characterized for a fluid by inhalation / carrying out the regurgitation from said outflow/entrance by having an energized part which impresses voltage or a magnetic field to said volume variable member, carrying out release of energization to said energized part, or energization, and changing volume of said volume variable member.

[0010](2) A pump given in the above (1) in which said fluid is a working fluid.

[0011](3) A pump the above (1) by which said volume variable member is constituted from piezoelectric material or a magnetostrictive material, or given in (2).

[0012](4) A pump the above (1) which has said two or more volume variable members thru/or given in either of (3).

[0013](5) A pump given in the above (4) which said two or more volume variable members make tabular, respectively, leaves a crevice in the thickness direction, and is arranged in piles.

[0014](6) Said energized part is individually provided to said each volume variable member, respectively, and it is a pump the above (4) which can impress voltage or a magnetic field independently, respectively, or given in (5) to said each volume variable member.

[0015](7) A pump the above (1) for which said housing is making cylindrical shape mostly thru/or given in either of (6).

[0016](8) A pump the above (1) which is making shape with said flat housing thru/or given in either of (6).

[0017](9) A pumping plant having a pump of a statement, and a pump control means which

controls an operation of said pump in the above (1) thru/or either of (8).
[0018](10) By adjusting energizing voltage to said energized part, it is a pumping plant given in the above (9) which can adjust inhalation/discharge quantity of a fluid.
[0019](11) Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, A pumping plant of the above (9) which can adjust inhalation/discharge quantity of a fluid or a statement to (10) by what the number of said energized part which can impress voltage or a magnetic field independently to said each volume variable member, respectively, and carries out release of energization or energization is adjusted for.
[0020](12) Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, A pumping plant the above (9) which sets a time lag to each energized part, and performs release of energization or energization when voltage or a magnetic field can be independently impressed to said each volume variable member, respectively and release of energization or energization is carried out to said two or more energized parts thru/or given in either of (11).
[0021](13) By adjusting said time lag, it is a pumping plant given in the above (12) which can adjust inhalation/discharge velocity of a fluid.
[0022](14) Have a nozzle applied part which can equip with a nozzle so that it may be open for free passage at said outflow/entrance of a pump the above (1) thru/or given in either of (8), and said pump, and by the operation of said pump. A distributive-pouring head characterized for a fluid by inhalation / carrying out the regurgitation and pouring a fluid distributively from a tip opening of said nozzle.
[0023](15) A distributive-pouring head array which installs two or more distributive-pouring heads of a statement in the above (14) side by side, and is characterized by things.
[0024](16) A distributive-pouring head array given in the above (15) which said each distributive-pouring head is making flat shape, and installs said two or more distributive-pouring heads in the thickness direction side by side.
[0025](17) A distributive-pouring device equipping the above (9) thru/or either of (13) with a pumping plant of a statement at least one as a suction means.
[0026](18) A distributive-pouring device equipping the above (14) with at least one distributive-pouring head of a statement.
[0027]
[Embodiment of the Invention]Hereafter, the pump of this invention, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device are explained in detail based on the suitable embodiment shown in an accompanying drawing.
[0028]The perspective view showing the volume variable member in the distributive-pouring head which shows drawing 2 drawing of longitudinal section showing the distributive-pouring

head and nozzle in the distributive-pouring device which shows drawing 1 the perspective view in which drawing 1 shows the embodiment of the distributive-pouring device of this invention, and drawing 2, and drawing 3, and drawing 4 are the block diagrams of the distributive-pouring device shown in drawing 1.

[0029]As shown in drawing 1, the distributive-pouring device 1 is provided with the following.

Device main frame 2.

Distributive-pouring head 3.

Distributive-pouring head transportation device 4.

The distributive-pouring device 1 is provided with the pumping plant 6 of this invention as a suction means. This distributive-pouring device 1 is inhalation and a thing which carries out the regurgitation and does classification of the fluid 500, dilution, mixing, dropping work, etc. about the fluids 500, such as a drug solution and a sample, from the tip opening 302 of the nozzle 300 with which the distributive-pouring head 3 was equipped with the suction force which the pump 5 which the pumping plant 6 has generates.

[0030]The device main frame 2 has the stage 21. On the stage 21, the reagent vessel stowage 22, the reaction vessel stowage 23, and the nozzle stowage 24 are formed, respectively.In the reagent vessel stowage 22, can store two or more reagent vessels 100 which store a drug solution (charge), and to it in the reaction vessel stowage 23. Two or more reaction vessels 200 which store reaction mixture can be stored (charge), and two or more nozzles 300 for exchange can be stored in the nozzle stowage 24 (charge).

[0031]As shown in drawing 2, the distributive-pouring head 3 is provided with the following.

The pump 5 of this invention.

The nozzle applied part 31 which can equip with the nozzle 300.

Hereafter, the composition of this distributive-pouring head 3 is explained.

[0032]The pump 5 is provided with the following.

Housing 51.

Two or more volume variable members 52 installed in the housing 51.

The energized part 53 which impresses voltage to the volume variable member 52 by energization.

[0033]The housing 51 is a case which makes cylindrical shape mostly. This housing 51 comprises material with various metallic materials, ceramics, a hard resin material, etc. hard, for example, and has become a rigid body which is not expanded and contracted substantially.

[0034]The air (gas) as a working fluid flows into the pars basilaris ossis occipitalis of the housing 51, and the outflow entrance 511 which carries out ON is formed in it. The seal of the portions other than outflow entrance 511 of the housing 51 is carried out so that it may not let a

fluid pass, and airtightness (fluid-tight nature) is secured.

[0035]The volume variable member [two or more (the composition of a graphic display 14 pieces)] 52 is installed in the building envelope of the housing 51. These volume variable members 52 are the same composition mutually, and are making disc-like, respectively.

[0036]The volume variable member 52 comprises a substance from which volume changes by impressing voltage (electric field). Especially as such a substance, although not limited, piezoelectric material, such as crystal (SiO_2), lithium niobate, barium titanate, lead titanate, lead zirconate titanate (PZT), a lead metaniobate, and polyvinylidene fluoride (PVDF), is mentioned, for example.

[0037]As shown in drawing 3, to each volume variable member 52, the energized part 53 is formed individually, respectively. The energized part 53 comprises the laminated electrodes 531 and 532 and the leads (signal wire) 533 and 533 connected to the electrodes 531 and 532, respectively. The electrode 531 is contacted and formed in one field of the volume variable member 52, and the electrode 532 is contacted and formed in the field of another side of the volume variable member 52. The leads 533 and 533 are electrically connected to the pump drive circuit 12 provided outside, respectively. In drawing 2, the graphic display of the electrodes 531 and 532 and the lead 533 is omitted.

[0038]As shown in drawing 2, two or more disc-like members which consist of the volume variable member 52 and the electrodes 531 and 532 leave the crevice into which a fluid may invade, and are arranged mostly in piles at equal intervals in the thickness direction. By such arrangement, two or more volume variable members 52 can be efficiently arranged to the space in the housing 51, and it contributes to the miniaturization of the pump 5.

[0039]The supporting structure within the housing 51 of the disc-like member which consists of the volume variable member 52 and the electrodes 531 and 532 can be made into the supporting structure using the spacer which what kind of thing may be sufficient as, for example, is not illustrated. This supporting structure is the structure which can free modification which each volume variable member 52 mentions later.

[0040]As shown in drawing 4, it is connected to the control section (CPU) 11, and the pump drive circuit 12 is energized to the energized part 53 based on the control signal from the control section 11. The control section 11 controls the operation of the pump 5 like the after-mentioned based on the application program for controlling the pump 5 stored in the storage parts store 18, and the input data inputted from the input part 19. The pump control means 13 which controls the operation of the pump 5 comprises the control section 11, the pump drive circuit 12, the storage parts store 18, and the input part 19.

[0041]If it energizes to the energized part 53, the voltage (electric field) produced between the electrode 531 and the electrode 532 will be impressed to the volume variable member 52. According to the piezo-electric effect, it will elongate to the thickness direction and the volume

variable member 52 will be contracted to a diametral direction, if voltage is impressed. And if impression of voltage is canceled, the volume variable member 52 will return to the original shape.

[0042]When the volume of the volume variable member 52 before and after such modification is measured, the volume of the volume variable member 52 in the state where voltage was impressed is slightly larger than the volume in the state where voltage is not impressed. That is, if the volume variable member 52 impresses voltage, volume will increase, and if impression of voltage is canceled, volume will decrease.

[0043]Since the capacity of the left-behind space (space which is not occupied by volume variable member 52 grade) in the housing 51 will decrease if the volume of the volume variable member 52 increases, the air in the housing 51 flows out and it flows out from the entrance 511. On the contrary, since the capacity of the left-behind space in the housing 51 will increase if the volume of the volume variable member 52 decreases, air flows out and it flows in the housing 51 from the entrance 511. Thus, as for the pump 5, inhalation and the regurgitation carry out air from the outflow entrance 511.

[0044]The pumping plant 6 of this invention comprises such a pump 5 and the pump control means 13 (refer to drawing 4).

[0045]As shown in drawing 2, the nozzle applied part 31 is formed in the pump 5 bottom. The channel 311 which is open for free passage at the outflow entrance 511 is formed in the inside of the nozzle applied part 31. If the nozzle applied part 31 is equipped with the nozzle 300, the lumen of the nozzle 300 will flow out via the channel 311, and will be open for free passage at the entrance 511 (inside of the housing 51).

[0046]The portion by the side of the lower end of the nozzle applied part 31 is the tapered shape which an outer diameter dwindles toward down. When this tapered shape portion inserts without a crevice and fits in in the end face opening 301 of the nozzle 300, the nozzle 300 is fixed in airtight to the nozzle applied part 31, enabling free attachment and detachment. the nozzle 300 comprises various resin materials etc. preferably, for example -- being disposable (throwing away) -- it has become.

[0047]When pouring a different fluid distributively, contamination can be prevented by exchanging the nozzle 300. As for exchange of the nozzle 300, it is preferred that the nozzle replacement mechanism in which make it move to the nozzle stowage 24, and the distributive-pouring head 3 is not illustrated can perform now automatically.

[0048]It may be what it may be equipped with the nozzle 300 by screwing in this invention not only to composition like a graphic display but to the nozzle applied part 31, enabling free attachment and detachment, and the nozzle 300 cannot detach and attach to the distributive-pouring head 3.

[0049]As shown in drawing 1, the distributive-pouring head transportation device 4 is provided

with the following.
The rising and falling mechanism 41 which supports the distributive-pouring head 3 which was explained above movable in the perpendicular direction (Z shaft orientations).
Y axial movement mechanism 42 which moves the rising and falling mechanism 41 horizontally (Y shaft orientations).
X axial movement mechanism 43 which moves Y axial movement mechanism 42 to a horizontal direction (X axial direction) vertical to a Y-axis.
By such composition, the distributive-pouring head transportation device 4 can move the distributive-pouring head 3 now in the direction of a three dimension on the stage 21.
[0050]The operation of the distributive-pouring head transportation device 4 is controlled by the control section 11 based on the application program for controlling the distributive-pouring head transportation device 4 stored in the storage parts store 18, and the input data inputted from the input part 19.
[0051]The rising and falling mechanism 41, Y axial movement mechanism 42, and X axial movement mechanism 43 can be used as the arbitrary mechanisms which the mechanism of what kind of structure may be sufficient as, for example, used a feed screw, a rack & pinion gear, a servo motor, a fluid pressure cylinder, etc.
[0052]Such a distributive-pouring device 1 does the distributive-pouring work of classification of the fluid 500, dilution, mixing, dropping, etc., moving the distributive-pouring head 3 between each reagent vessel 100 and each reaction vessel 200 by the operation of the distributive-pouring head transportation device 4.
[0053]Hereafter, the case where the fluid 500 in the reagent vessel 100 is classified for the operation of the distributive-pouring device 1 to the reaction vessel 200 is explained to an example.
[0054][1] The tip opening 302 of the nozzle 300 energizes on predetermined voltage to all the energized parts 53 by the state of being in the air, first. All the volume variable members 52 will be increased by volume by this.
[0055][2] Rank second, operate the distributive-pouring head transportation device 4, and move the distributive-pouring head 3 so that the tip opening 302 of the nozzle 300 may be located below the oil level of the fluid 500 in the reagent vessel 100.
[0056][3] In this state, if the energization to the energized part 53 is canceled, when the volume of the volume variable member 52 decreases, the air in the nozzle 300 will flow out, it will be inhaled in the housing 51 from the entrance 511, and the pressure in the nozzle 300 will decline. The fluid 500 is inhaled in the nozzle 300 from the tip opening 302 by this failure of pressure (refer to drawing 2).
[0057]At this time, the quantity of the fluid 500 inhaled in the nozzle 300 can be adjusted by adjusting the number of the energized part 53 which cancels energization. That is, when the

number of the energized part 53 which cancels energization is one piece, the fluid 500 of the quantity corresponding to the amount of volume decreases of the one volume variable member 52 is inhaled in the nozzle 300. And the suction quantity of the fluid 500 will be the 2 and 3, ..., 14 times in general to the time of canceling energization of the one energized part 53 by considering it as two pieces, three pieces, ..., the 14 number of the energized part 53 which cancels energization. Thus, the suction quantity of the fluid 500 can be adjusted to 14 steps.

[0058]When it is a thing of the character in which volume does not return to the original size (size of a standard) thoroughly at this time even if the volume variable member 52 makes impressed electromotive force zero, That is, when it is what has a hysteresis in the volume change of the volume variable member 52, after canceling the energization to the energized part 53, it is good also as performing control which impresses the voltage of an opposite direction to the energized part 53 so that the volume of the volume variable member 52 may return to the size of a standard. The fixed reference voltage in the energized part 53 is impressed in front of the above [1], Voltage higher than this can be impressed to the energized part 53 by [1], control of returning the impressed electromotive force to the energized part 53 to said reference voltage by [3] may be carried out, and influence of a hysteresis can be made small by this control. Higher-precision distributive pouring can be performed by performing these control [like]. In this specification, as mentioned above, after canceling the energization to the energized part 53, it is only called "release of energization" also including the case where the voltage of an opposite direction is impressed, and the case where the impressed electromotive force to the energized part 53 is returned to a certain fixed reference voltage.

[0059]In inhalation operation of such a fluid 500, if the energization to those energized parts 53 is simultaneously canceled when canceling the energization to two or more energized parts 53, the fluid 500 can be inhaled at high speed.

[0060]When canceling the energization to two or more energized parts 53, a time lag may be set to each energized part 53, and energization may be canceled. In this case, the suction speed of the fluid 500 can be adjusted by adjusting that time lag. That is, if the time lag is lengthened, suction speed can be made late, and suction speed can be made quick if the time lag is shortened.

[0061][4] If the fluid 500 is inhaled in the nozzle 300, the distributive-pouring head transportation device 4 will be operated, and the distributive-pouring head 3 will be moved to the position of the reaction vessel 200.

[0062][5] Rank second and energize on predetermined voltage again to the energized part 53 which canceled energization. The volume of the energized volume variable member 52 increases by this, the air in the housing 51 flows out, it flows out of the entrance 511, and the pressure in the nozzle 300 increases. The regurgitation (discharge) of the fluid 500 in the nozzle 300 is carried out from the tip opening 302 by this pressure increase. By making this

breathed-out fluid 500 dropped at the reaction vessel 200 (fall), it gives into the reaction vessel 200. When adhered to the tip opening 302 neighborhood by the breathed-out fluid 500, It is better also as giving the breathed-out fluid 500 into the reaction vessel 200 than operate the distributive-pouring head transportation device 4 and contacting the tip part of the nozzle 300 into the wall of the reaction vessel 200, or the fluid in it.

[0063]In the case of such discharging of the fluid 500, the quantity of the fluid 500 which carries out the regurgitation can be adjusted by adjusting the number of the energized part 53 to energize like the time of the aforementioned inhalation operation.

[0064]If it energizes simultaneously to those energized parts 53 when energizing to two or more energized parts 53 in discharging of such a fluid 500, the regurgitation of the fluid 500 can be carried out at high speed. Depending on conditions, such as discharge quantity and an opening diameter of the tip opening 302, from the nozzle 300, as the fluid 500 is injected, the regurgitation can also be carried out.

[0065]When energizing to two or more energized parts 53 in discharging of the fluid 500, a time lag may be set and energized to each energized part 53. In this case, the discharge velocity of the fluid 500 can be adjusted by adjusting that time lag. That is, if the time lag is lengthened, discharge velocity can be made late, and discharge velocity can be made quick if the time lag is shortened.

[0066][6] By moving the distributive-pouring head 3 to other reaction vessels 200, and repeating operation of [5], the fluid 500 in the reagent vessel 100 is classifiable to each reaction vessel 200.

[0067]Thus, by the volume change of the volume variable member 52, in a fluid, the regurgitation is carried out and the pump 5 of this invention does not have [inhalation and] a mechanical flexible region. Therefore, since adverse effects, such as mechanical backlash and a backlash, are not received, suction quantity and discharge quantity are controllable by high accuracy (adjustment). In particular, in high accuracy, it can inhale and the regurgitation also of very little fluids can be carried out. Structure is easy and contributes also to reduction of a manufacturing cost. Since there is no flexible region, there is little fear of failure and it is excellent also in endurance.

[0068]In the distributive-pouring head 3 and the distributive-pouring device 1 of this invention provided with such a pump 5 (pumping plant 6), the amount of distributive pouring can be controlled by high accuracy (adjustment), and very little fluids can also be especially poured distributively in high accuracy.

[0069]In this embodiment, the energized part 53 is individually formed to two or more volume variable members 52, respectively, and when impression has become possible about voltage independently to each volume variable member 52, respectively, suction quantity and discharge quantity can be adjusted easily and with high precision. In this invention, when

forming two or more volume variable members 52, the number in particular is not limited, for example, can be made into about 2-1000 pieces. By increasing the number of the volume variable member 52, suction quantity and discharge quantity can be adjusted more broadly from a minute amount to comparatively large quantity, and with high precision.

[0070]The setting number of the volume variable member 52 seems to have become settled in the value predetermined in suction quantity and discharge quantity in this invention at one piece. Even when the number of the volume variable members 52 is one, by adjusting the energizing voltage to the energized part 53, the amount of volume changes of the volume variable member 52 can be adjusted, and, thereby, suction quantity and discharge quantity can also be adjusted.

[0071]Also when two or more volume variable members 52 are installed, it may be made to adjust the energizing voltage to the energized part 53. Thereby, suction quantity and discharge quantity can be adjusted with the more sufficient accuracy on a multi stage story.

[0072]Volume seems to decrease by impression of voltage in this invention to the embodiment and reverse which the volume variable member 52 mentioned above.

[0073]Although the target fluid 500 was poured distributively inhalation and by carrying out the regurgitation by using air (gas) as a working fluid in this embodiment, an insulating fluid may be sufficient as a working fluid in this invention. That is, it fills up with an insulating liquid in the housing 51, and the fluid 500 may be poured distributively via inhalation and the insulating liquid which carries out the regurgitation from the outflow entrance 511. When an insulating tunic is formed in the volume variable member 52 and the surface of the energized part 53, a fluid without insulation may be sufficient as a working fluid.

[0074]A volume variable member may be constituted from this invention by impression of a magnetic field by the substance from which volume changes (magnetostrictive effects). Especially as such a substance, although not limited, various magnetostrictive materials, such as a Tb-Dy-Fe alloy, a super magnetostriction material, etc. are mentioned, for example. In this case, as an energized part, the coil which impresses a magnetic field to this volume variable member by energization can be used, for example.

[0075]Drawing 5 is a perspective view showing the embodiment of the distributive-pouring head array of this invention. Hereafter, although the embodiment of the distributive-pouring head array of this invention is described with reference to this figure, it explains focusing on a point of difference with the embodiment mentioned above, and the same matter omits that explanation.

[0076]The distributive-pouring head array 7 shown in drawing 5 installs the distributive-pouring head [two or more (the composition of a graphic display 16 pieces)] 71 side by side. The distributive-pouring head 71 is the same as said distributive-pouring head 3 except the shape differing.

[0077]The housing 711 of the pump in the distributive-pouring head 71 is making flat rectangular parallelepiped shape. In the housing 711, the tabular volume variable member with long and slender plurality (large number) is arranged in piles.
[0078]The distributive-pouring head array 7 installs two or more such thin distributive-pouring heads 71 in the thickness direction side by side at a single tier. Since the mechanical driving source is an easy unnecessary structure, the pump of this invention has the high flexibility of shape. Therefore, such a thin distributive-pouring head 71 and the small distributive-pouring head array 7 of an array pitch are easily realizable.
[0079]When pouring distributively to the microplate (multi-hole plate) which can be poured distributively at once to two or more places for example, by which many holes were formed in matrix form according to the distributive-pouring device provided with such a distributive-pouring head array 7, it can pour distributively promptly at very high efficiency.
[0080]Drawing 6 is drawing of longitudinal section showing other embodiments of the pump of this invention. Hereafter, although other embodiments of the pump of this invention are described with reference to this figure, it explains focusing on a point of difference with the embodiment mentioned above, and the same matter omits that explanation.
[0081]Pump 5' of this embodiment sends out a fluid toward right-hand side from the left-hand side in drawing 6. This pump 5' is applicable to other devices of various kinds of which send out not only a distributive-pouring device but a fluid.
[0082]Pump 5' is provided with the following.
It has the almost same composition as said pump 5, and is housing 51'.
Two or more volume variable members 52 installed in housing 51'.
The energized part 53 which impresses voltage to the volume variable member 52 by energization.

[0083]The input 512 where a fluid flows, and the tap hole 513 where a fluid flows out are established in housing 51', respectively. That is, in this embodiment, the input 512 and the tap hole 513 are separately formed in housing 51'. In the middle of the channel 14 connected to the input 512, the check valve (check valve) 16 is formed and the check valve (check valve) 17 is formed in the middle of the channel 15 connected to the tap hole 513.
[0084]If pump 5' operates like the above, pump 5' will inhale a fluid from the input 512, and will carry out the regurgitation of the fluid from the tap hole 513. Thereby, the fluid in the channel 14 and 15 can be sent out rightward in drawing 6.
[0085]That is, although said pumps 5 were inhalation and a thing which carries out the regurgitation about the target fluid 500 via the air (gas) which is a working fluid, directly, it inhales and breathes out and pump 5' of this embodiment sends out the target fluid.
[0086]As a fluid which pump 5' sends out, a fluid or a gas may be sufficient. In the case of a

fluid, it is preferred that the insulating tunic is formed in the volume variable member 52 and the surface of the energized part 53.

[0087]Although there may not be the check valves 16 and 17, it is preferred that at least one side of the check valves 16 and 17 is provided.

[0088]As mentioned above, although the embodiment of the graphic display of the pump, the pumping plant, the distributive-pouring head, distributive-pouring head array, and distributive-pouring device of this invention was described, This invention is not limited to this and each part which constitutes a pump, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device can be replaced by the thing of arbitrary composition of that the same function can be exhibited. Arbitrary structures may be added.

[0089]Although this invention is applicable from what has 1 time of comparatively large inhalation / discharge quantity to a very small quantity thing, 1 time of inhalation/discharge quantity are suitable for it to the minute amount thing which is about 1 nano liter -100 microliter especially.

[0090]The thing of what kind of shape, such as not only a tabular thing but rod form, block like shape, etc., may be sufficient as a volume variable member. What kind of thing may be sufficient also as the modification mode of a volume variable member when voltage or a magnetic field is impressed.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a perspective view showing the embodiment of the distributive-pouring device of this invention.

[Drawing 2]It is drawing of longitudinal section showing the distributive-pouring head and nozzle in the distributive-pouring device shown in drawing 1.

[Drawing 3]It is a perspective view showing the volume variable member in the distributive-pouring head shown in drawing 2.

[Drawing 4]It is a block diagram of the distributive-pouring device shown in drawing 1.

[Drawing 5]It is a perspective view showing the embodiment of the distributive-pouring head array of this invention.

[Drawing 6]It is drawing of longitudinal section showing other embodiments of the pump of this invention.

[Description of Notations]

1 Distributive-pouring device
2 Device main frame
21 Stage
22 Reagent vessel stowage
23 Reaction vessel stowage
24 Nozzle stowage
3 Distributive-pouring head
31 Nozzle applied part
311 Channel
4 Distributive-pouring head transportation device
41 Rising and falling mechanism
42 Y axial movement mechanism

43 X axial movement mechanism
5 and 5' pump
51 and 51' housing
511 Outflow entrance
512 Input
513 Tap hole
52 Volume variable member
53 Energized part
531 and 532 Electrode
533 Lead
6 Pumping plant
7 Distributive-pouring head array
71 Distributive-pouring head
711 Housing
11 Control section
12 Pump drive circuit
13 Pump control means
14 and 15 Channel
16 and 17 Check valve
18 Storage parts store
19 Input part
100 Reagent vessel
200 Reaction vessel
300 Nozzle
301 End face opening
302 Tip opening
500 Fluid

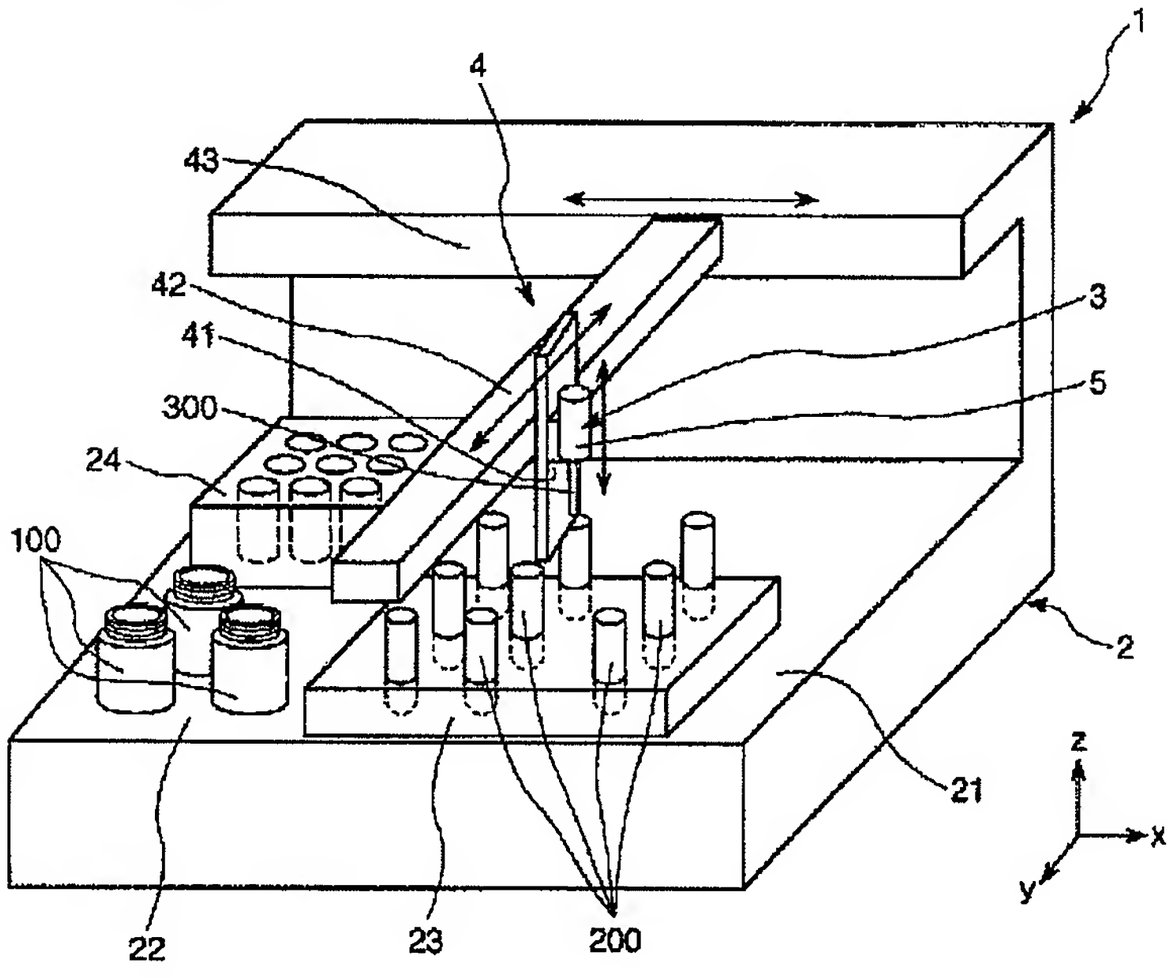
[Translation done.]

* NOTICES *

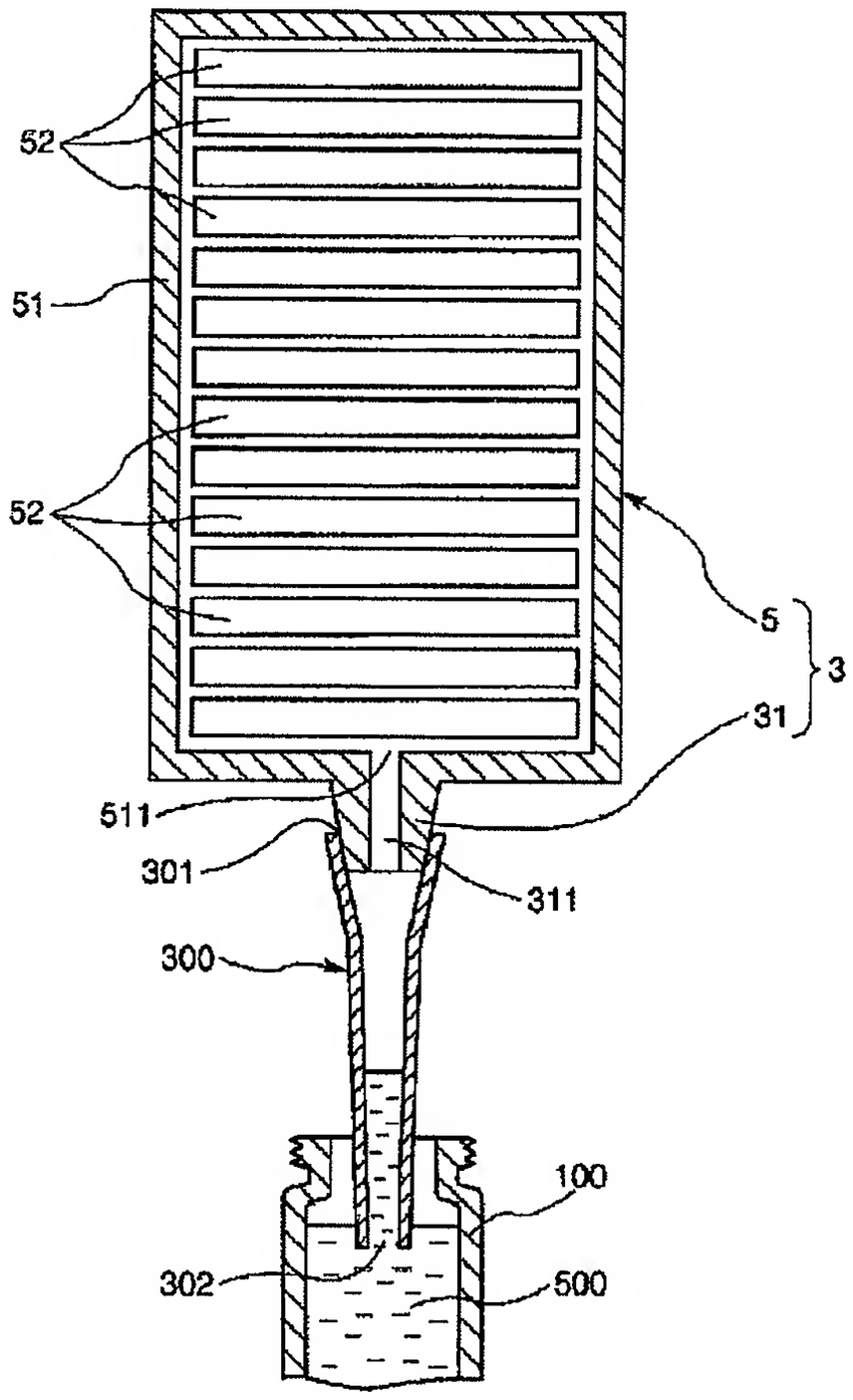
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

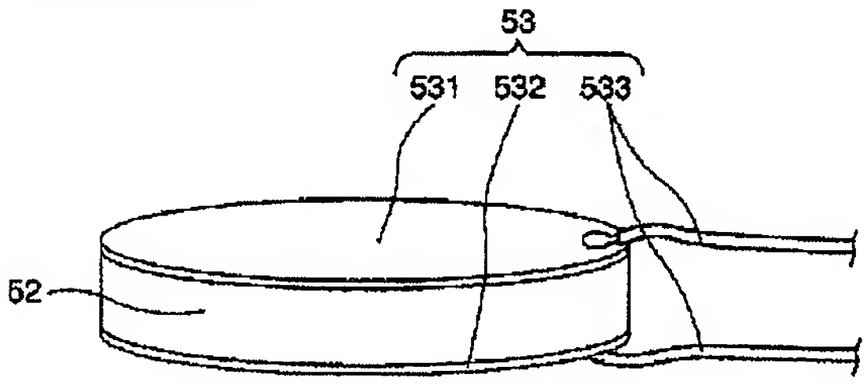
[Drawing 1]



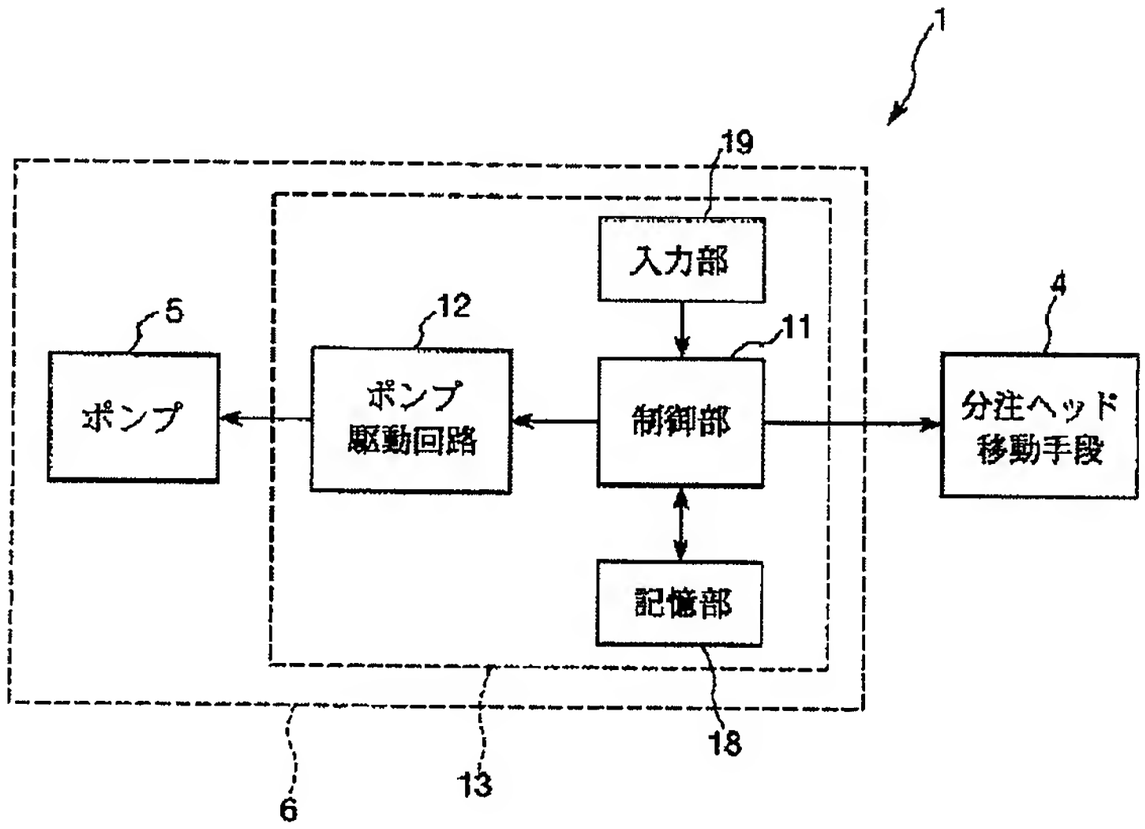
[Drawing 2]



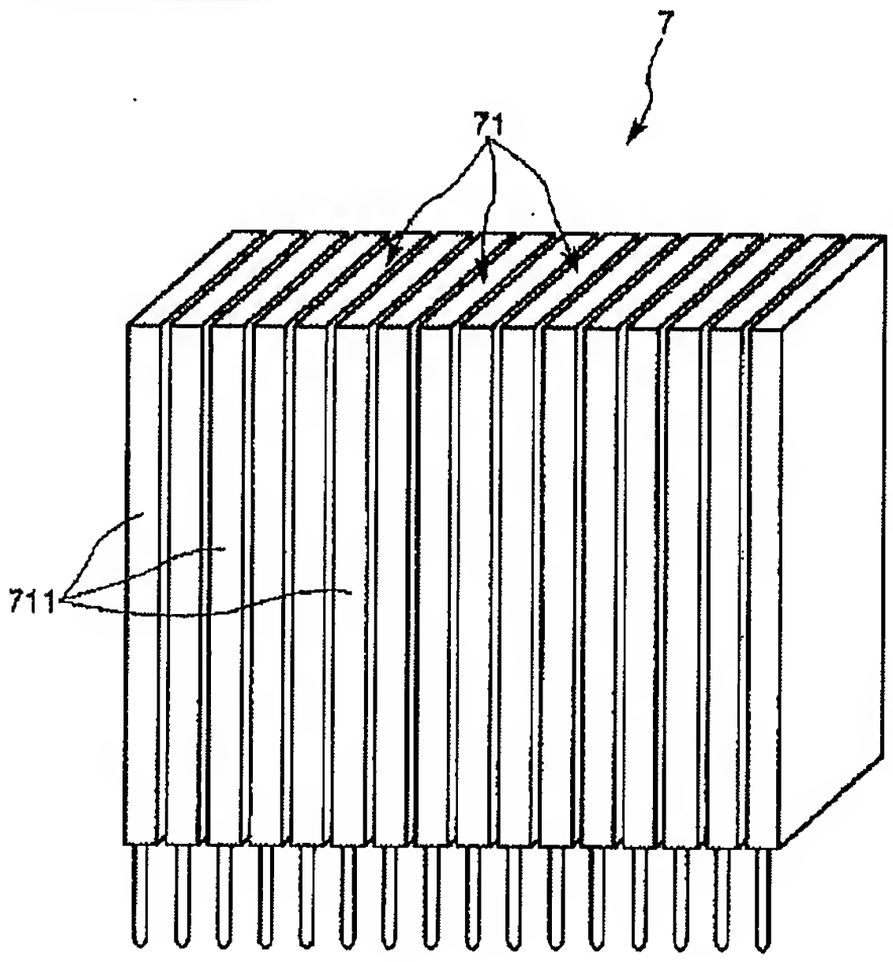
[Drawing 3]



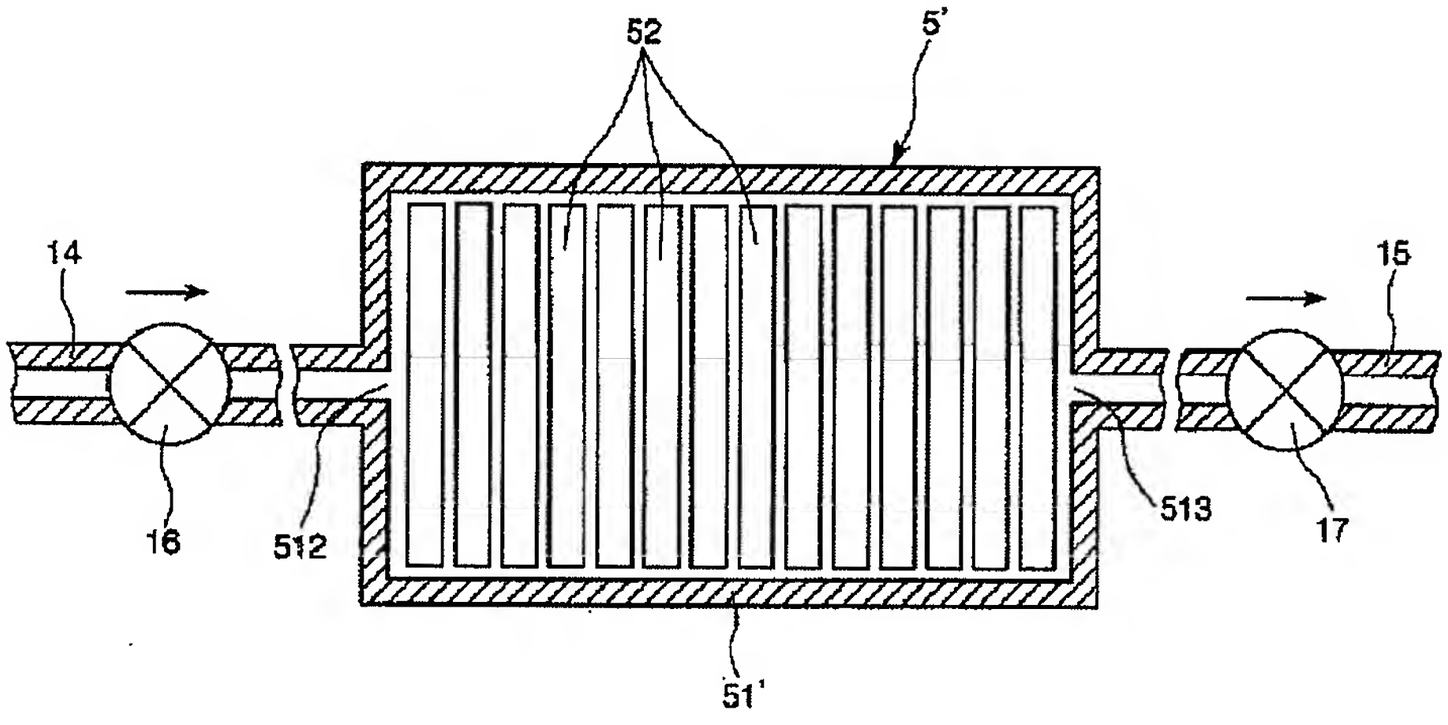
[Drawing 4]



[Drawing 5]

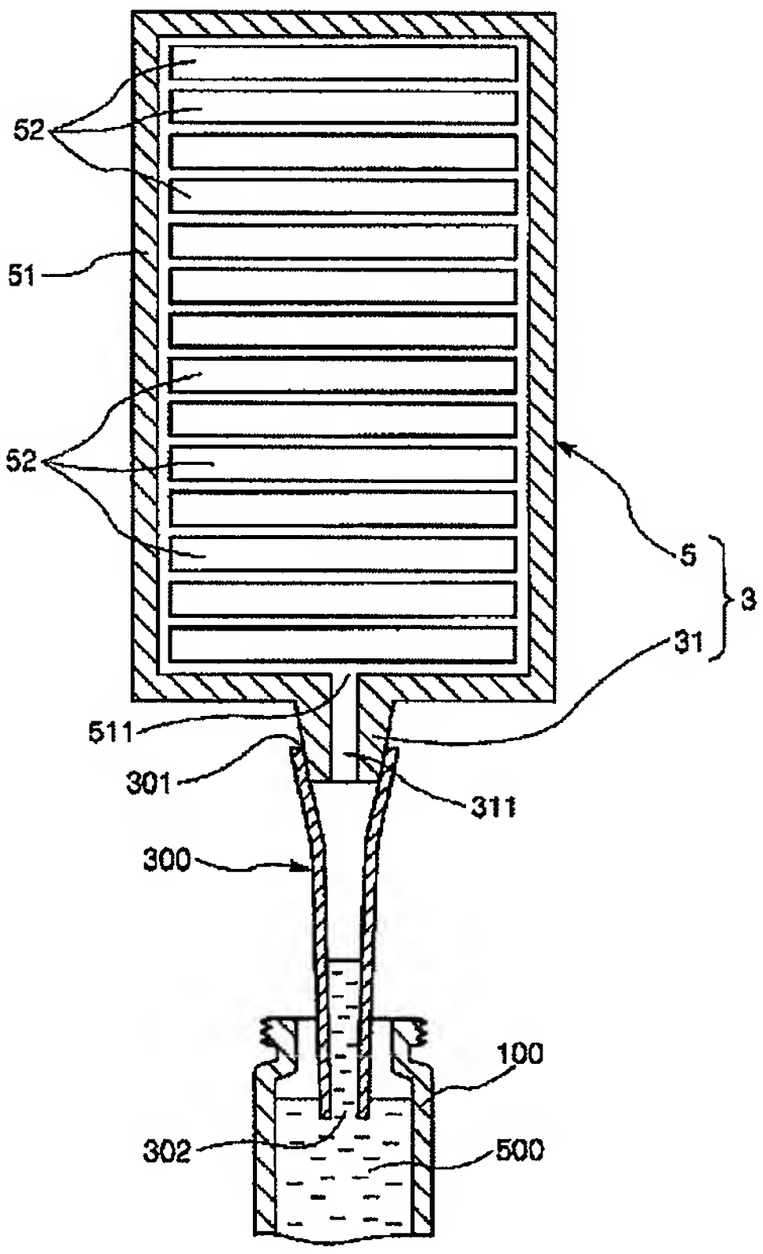


[Drawing 6]



[Translation done.]

Drawing selection Representative drawing



[Translation done.]

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審査請求　未請求　請求項の数18　ＯＬ　（全９頁）

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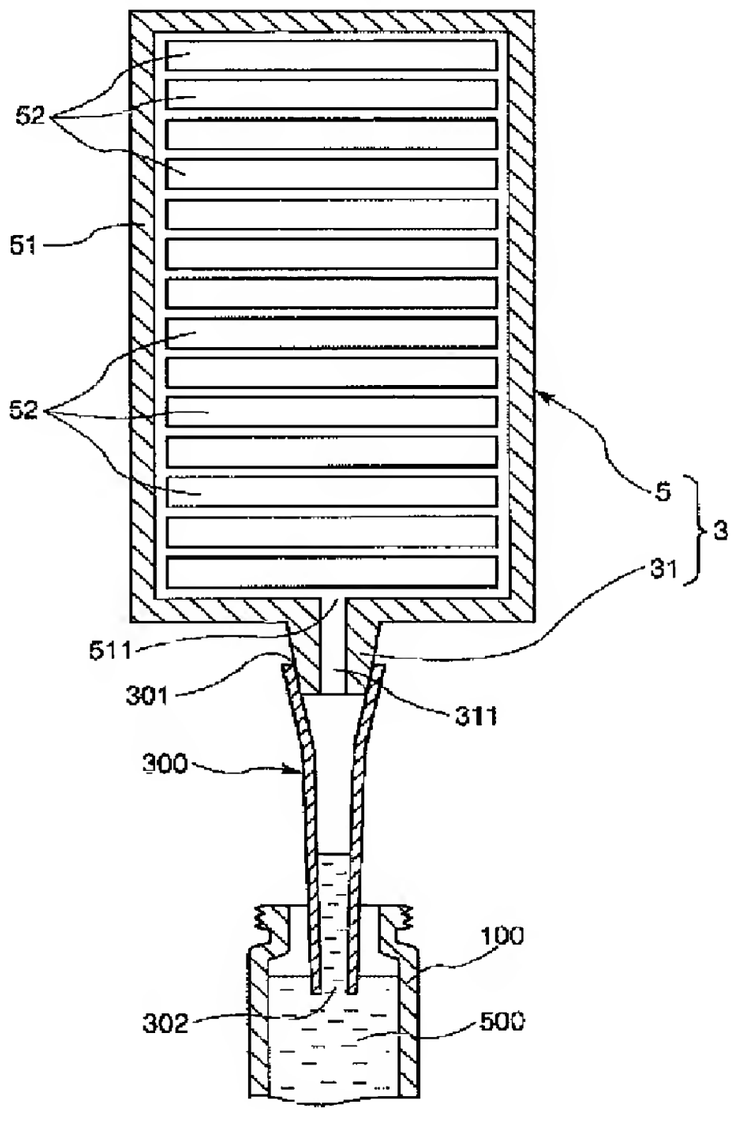
最終頁に続く

(54)【発明の名称】　ポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置

(57)【要約】
【課題】簡単な構造で、高い精度で流体の吸入・吐出を行うことができるポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を提供すること。
【解決手段】分注ヘッド３は、ポンプ５と、ノズル３００を装着可能なノズル装着部３１とを有している。ポンプ５は、ハウジング５１と、ハウジング５１内に設置された複数の体積可変部材５２と、通電により体積可変部材５２に電圧を印加する通電部（電極）とを有している。体積可変部材５２に電圧を印加すると、その体積が増大し、ハウジング５１内の残された空間の容積が減少して、ハウジング５１内の空気が流出入口５１１より流出し、ノズル３００内の液体５００が吐出される。体積可変部材５２への電圧の印加を解除すると、体積可変部材５２の体積が減少し、ノズル３００内の空気が流出入口５１１よりハウジング５１内に流入し、ノズル３００内に液体５００が吸入される。



【特許請求の範囲】
【請求項１】　流体が流出／入する流出／入口が形成されたハウジングと、
前記ハウジング内に設置され、電圧または磁場を印加することにより体積が変化する物質で構成された少なくとも１つの体積可変部材と、
通電により、前記体積可変部材に電圧または磁場を印加する通電部とを有し、
前記通電部に対する通電または通電の解除をして、前記体積可変部材の体積を変化させることにより、前記流出／入口から流体を吸入／吐出することを特徴とするポンプ。
【請求項２】　前記流体は、作動流体である請求項１に記載のポンプ。
【請求項３】　前記体積可変部材は、圧電材料または磁歪材料で構成されている請求項１または２に記載のポンプ。
【請求項４】　複数個の前記体積可変部材を有する請求項１ないし３のいずれかに記載のポンプ。
【請求項５】　複数個の前記体積可変部材は、それぞれ板状をなし、その厚さ方向に隙間を空けて重ねて配置されている請求項４に記載のポンプ。
【請求項６】　前記各体積可変部材に対しそれぞれ個別に前記通電部が設けられており、前記各体積可変部材に対しそれぞれ独立して電圧または磁場を印加可能である請求項４または５に記載のポンプ。
【請求項７】　前記ハウジングは、ほぼ円筒状をなしている請求項１ないし６のいずれかに記載のポンプ。
【請求項８】　前記ハウジングは、扁平な形状をなしている請求項１ないし６のいずれかに記載のポンプ。
【請求項９】　請求項１ないし８のいずれかに記載のポンプと、前記ポンプの作動を制御するポンプ制御手段とを有することを特徴とするポンプ装置。
【請求項１０】　前記通電部への通電電圧を調整することにより、流体の吸入／吐出量を調整可能である請求項９に記載のポンプ装置。
【請求項１１】　前記ポンプは、複数個の前記体積可変部材と、各体積可変部材に対しそれぞれ個別に設けられた前記通電部とを有し、前記各体積可変部材に対しそれぞれ独立に電圧または磁場を印加可能であり、
通電または通電の解除をする前記通電部の個数を調整することにより、流体の吸入／吐出量を調整可能である請求項９または１０に記載のポンプ装置。
【請求項１２】　前記ポンプは、複数個の前記体積可変部材と、各体積可変部材に対しそれぞれ個別に設けられた前記通電部とを有し、前記各体積可変部材に対しそれぞれ独立に電圧または磁場を印加可能であり、
複数個の前記通電部に通電または通電の解除をする際、各通電部に対し時間差をおいて通電または通電の解除を行う請求項９ないし１１のいずれかに記載のポンプ装置。
【請求項１３】　前記時間差を調整することにより、流体の吸入／吐出速度を調整可能である請求項１２に記載のポンプ装置。
【請求項１４】　請求項１ないし８のいずれかに記載のポンプと、前記ポンプの前記流出／入口に連通するようにノズルを装着可能なノズル装着部とを有し、
前記ポンプの作動により、前記ノズルの先端開口から液体を吸入／吐出して、液体を分注することを特徴とする分注ヘッド。
【請求項１５】　請求項１４に記載の分注ヘッドを複数並設してなることを特徴とする分注ヘッドアレイ。
【請求項１６】　前記各分注ヘッドは、扁平な形状をなしており、複数個の前記分注ヘッドをその厚さ方向に並設してなる請求項１５に記載の分注ヘッドアレイ。
【請求項１７】　請求項９ないし１３のいずれかに記載のポンプ装置を吸引手段として少なくとも１つ備えることを特徴とする分注装置。
【請求項１８】　請求項１４に記載の分注ヘッドを少なくとも１つ備えることを特徴とする分注装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、ポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置に関する。
【０００２】
【従来の技術】例えば検体、試薬等の少量の液体の仕分け、希釈、混合、滴下作業などを行う分注装置が知られている。この分注装置は、例えば臨床検査の分野や基礎研究の分野などにおいて使用されている。
【０００３】従来の分注装置における分注ヘッドは、筒状体とこの筒状体内で摺動するピストンとを有するシリンジと、ピストンを移動させるピストン移動機構と、シリンジ内に連通するノズルとを備えている。そして、ピストン移動機構によってピストンを移動させ、シリンジ内の圧力を変化させることにより、ノズルの先端開口から液体を吸入・吐出する。
【０００４】しかしながら、従来の分注ヘッドでは、例えば送りねじなどを用いた機械的なピストン移動機構を必要とするため、構造が複雑であり、製造コストが高いという問題があった。
【０００５】また、ピストン移動機構の機械的ガタ、バックラッシュなどにより、ピストンの位置制御の精度向上が困難であるため、分注量の精度を向上するのが困難であった。特に、微量の液体を高い精度で分注することができなかった。
【０００６】また、ピストン移動機構は、機械的な動作を行うものであるため、比較的故障を起こし易く、耐久性にも劣っていた。
【０００７】

【発明が解決しようとする課題】本発明の目的は、簡単な構造で、高い精度で流体の吸入・吐出を行うことができるポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を提供することにある。

【０００８】

【課題を解決するための手段】このような目的は、下記（１）～（１８）の本発明により達成される。

【０００９】（１）　流体が流出／入する流出／入口が形成されたハウジングと、前記ハウジング内に設置され、電圧または磁場を印加することにより体積が変化する物質で構成された少なくとも１つの体積可変部材と、通電により、前記体積可変部材に電圧または磁場を印加する通電部とを有し、前記通電部に対する通電または通電の解除をして、前記体積可変部材の体積を変化させることにより、前記流出／入口から流体を吸入／吐出することを特徴とするポンプ。

【００１０】（２）　前記流体は、作動流体である上記（１）に記載のポンプ。

【００１１】（３）　前記体積可変部材は、圧電材料または磁歪材料で構成されている上記（１）または（２）に記載のポンプ。

【００１２】（４）　複数個の前記体積可変部材を有する上記（１）ないし（３）のいずれかに記載のポンプ。

【００１３】（５）　複数個の前記体積可変部材は、それぞれ板状をなし、その厚さ方向に隙間を空けて重ねて配置されている上記（４）に記載のポンプ。

【００１４】（６）　前記各体積可変部材に対しそれぞれ個別に前記通電部が設けられており、前記各体積可変部材に対しそれぞれ独立して電圧または磁場を印加可能である上記（４）または（５）に記載のポンプ。

【００１５】（７）　前記ハウジングは、ほぼ円筒状をなしている上記（１）ないし（６）のいずれかに記載のポンプ。

【００１６】（８）　前記ハウジングは、扁平な形状をなしている上記（１）ないし（６）のいずれかに記載のポンプ。

【００１７】（９）　上記（１）ないし（８）のいずれかに記載のポンプと、前記ポンプの作動を制御するポンプ制御手段とを有することを特徴とするポンプ装置。

【００１８】（１０）　前記通電部への通電電圧を調整することにより、流体の吸入／吐出量を調整可能である上記（９）に記載のポンプ装置。

【００１９】（１１）　前記ポンプは、複数個の前記体積可変部材と、各体積可変部材に対しそれぞれ個別に設けられた前記通電部とを有し、前記各体積可変部材に対しそれぞれ独立に電圧または磁場を印加可能であり、通電または通電の解除をする前記通電部の個数を調整することにより、流体の吸入／吐出量を調整可能である上記（９）または（１０）に記載のポンプ装置。

【００２０】（１２）　前記ポンプは、複数個の前記体積可変部材と、各体積可変部材に対しそれぞれ個別に設けられた前記通電部とを有し、前記各体積可変部材に対しそれぞれ独立に電圧または磁場を印加可能であり、複数個の前記通電部に通電または通電の解除をする際、各通電部に対し時間差をおいて通電または通電の解除を行う上記（９）ないし（１１）のいずれかに記載のポンプ装置。

【００２１】（１３）　前記時間差を調整することにより、流体の吸入／吐出速度を調整可能である上記（１２）に記載のポンプ装置。

【００２２】（１４）　上記（１）ないし（８）のいずれかに記載のポンプと、前記ポンプの前記流出／入口に連通するようにノズルを装着可能なノズル装着部とを有し、前記ポンプの作動により、前記ノズルの先端開口から液体を吸入／吐出して、液体を分注することを特徴とする分注ヘッド。

【００２３】（１５）　上記（１４）に記載の分注ヘッドを複数並設してなることを特徴とする分注ヘッドアレイ。

【００２４】（１６）　前記各分注ヘッドは、扁平な形状をなしており、複数個の前記分注ヘッドをその厚さ方向に並設してなる上記（１５）に記載の分注ヘッドアレイ。

【００２５】（１７）　上記（９）ないし（１３）のいずれかに記載のポンプ装置を吸引手段として少なくとも１つ備えることを特徴とする分注装置。

【００２６】（１８）　上記（１４）に記載の分注ヘッドを少なくとも１つ備えることを特徴とする分注装置。

【００２７】

【発明の実施の形態】以下、本発明のポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を添付図面に示す好適な実施形態に基づいて詳細に説明する。

【００２８】図１は、本発明の分注装置の実施形態を示す斜視図、図２は、図１に示す分注装置における分注ヘッドおよびノズルを示す縦断面図、図３は、図２に示す分注ヘッドにおける体積可変部材を示す斜視図、図４は、図１に示す分注装置のブロック図である。

【００２９】図１に示すように、分注装置１は、装置本体２と、分注ヘッド３と、分注ヘッド移動手段４とを有している。また、分注装置１は、本発明のポンプ装置６を吸引手段として備えている。この分注装置１は、ポンプ装置６が有するポンプ５が発生する吸引力により、分注ヘッド３に装着されたノズル３００の先端開口３０２から薬液、検体等の液体５００を吸入・吐出して、液体５００の仕分け、希釈、混合、滴下作業などを行うものである。

【００３０】装置本体２は、ステージ２１を有している。ステージ２１上には、試薬容器収納部２２と、反応容器収納部２３と、ノズル収納部２４とがそれぞれ設け

られている。試薬容器収納部２２には、薬液を貯留する試薬容器１００を複数個収納（装填）することができ、反応容器収納部２３には、反応液を貯留する反応容器２００を複数個収納（装填）することができ、ノズル収納部２４には、交換用のノズル３００を複数個収納（装填）することができる。

【００３１】図２に示すように、分注ヘッド３は、本発明のポンプ５と、ノズル３００を装着可能なノズル装着部３１とを有している。以下、この分注ヘッド３の構成について説明する。

【００３２】ポンプ５は、ハウジング５１と、ハウジング５１内に設置された複数の体積可変部材５２と、通電により体積可変部材５２に電圧を印加する通電部５３とを有している。

【００３３】ハウジング５１は、ほぼ円筒状をなす筐体である。このハウジング５１は、例えば各種金属材料、セラミック、硬質樹脂材料などの硬質な材料で構成され、実質的に伸縮しない剛体になっている。

【００３４】ハウジング５１の底部には、作動流体としての空気（気体）が流出入する流出入口５１１が形成されている。ハウジング５１の流出入口５１１以外の部分は、流体を通さないようにシールされ、気密性（液密性）が確保されている。

【００３５】ハウジング５１の内部空間には、複数個（図示の構成では、１４個）の体積可変部材５２が設置されている。これらの体積可変部材５２は、互いに同様の構成であり、それぞれ円板状をなしている。

【００３６】体積可変部材５２は、電圧（電場）を印加することにより体積が変化する物質で構成されている。このような物質としては、特に限定されないが、例えば、水晶（SiO_2）、ニオブ酸リチウム、チタン酸バリウム、チタン酸鉛、チタン酸ジルコン酸鉛（ＰＺＴ）、メタニオブ酸鉛、ポリフッ化ビニリデン（ＰＶＤＦ）等の圧電材料が挙げられる。

【００３７】図３に示すように、各体積可変部材５２に対しては、それぞれ個別に通電部５３が設けられている。通電部５３は、薄板状の電極５３１および５３２と、電極５３１および５３２にそれぞれ接続されたリード線（信号線）５３３、５３３とで構成されている。電極５３１は、体積可変部材５２の一方の面に接触して設けられており、電極５３２は、体積可変部材５２の他方の面に接触して設けられている。リード線５３３、５３３は、それぞれ、外部に設けられたポンプ駆動回路１２に対し電気的に接続されている。なお、図２中では、電極５３１、５３２およびリード線５３３の図示を省略する。

【００３８】図２に示すように、体積可変部材５２と電極５３１、５３２とからなる複数の円板状部材は、流体が侵入し得る隙間を空けてその厚さ方向にほぼ等間隔で重ねて配置されている。このような配置により、複数個の体積可変部材５２をハウジング５１内のスペースに効率よく配置することができ、ポンプ５の小型化に寄与する。

【００３９】なお、体積可変部材５２と電極５３１、５３２とからなる円板状部材のハウジング５１内での支持構造は、いかなるものでもよく、例えば図示しないスペーサを用いた支持構造とすることができる。また、この支持構造は、各体積可変部材５２が後述するような変形を自由にすることができるような構造になっている。

【００４０】図４に示すように、ポンプ駆動回路１２は、制御部（ＣＰＵ）１１に接続されており、制御部１１からの制御信号に基づいて、通電部５３に対し通電するものである。制御部１１は、記憶部１８に格納されたポンプ５を制御するためのアプリケーションプログラムや、入力部１９から入力された入力データに基づいて、ポンプ５の作動を後述のように制御する。なお、制御部１１と、ポンプ駆動回路１２と、記憶部１８と、入力部１９とで、ポンプ５の作動を制御するポンプ制御手段１３が構成される。

【００４１】通電部５３に通電されると、電極５３１と電極５３２との間に生じる電圧（電場）が体積可変部材５２に印加される。体積可変部材５２は、電圧が印加されると、圧電効果により、その厚さ方向に伸張し、直径方向に収縮する。そして、電圧の印加を解除すると、体積可変部材５２は、元の形状に戻る。

【００４２】このような変形の前後における体積可変部材５２の体積を比較すると、電圧を印加した状態での体積可変部材５２の体積は、電圧を印加していない状態での体積より、僅かに大きい。すなわち、体積可変部材５２は、電圧を印加すると体積が増大し、電圧の印加を解除すると、体積が減少する。

【００４３】体積可変部材５２の体積が増大すると、ハウジング５１内の残された空間（体積可変部材５２等に占有されていない空間）の容積が減少するため、ハウジング５１内の空気が流出入口５１１より流出する。逆に、体積可変部材５２の体積が減少すると、ハウジング５１内の残された空間の容積が増大するため、空気が流出入口５１１よりハウジング５１内に流入する。このようにして、ポンプ５は、流出入口５１１より空気を吸入・吐出する。

【００４４】なお、本発明のポンプ装置６は、このようなポンプ５と、ポンプ制御手段１３とで構成される（図４参照）。

【００４５】図２に示すように、ポンプ５の下側には、ノズル装着部３１が形成されている。ノズル装着部３１の内部には、流出入口５１１に連通する流路３１１が形成されている。ノズル装着部３１にノズル３００を装着すると、ノズル３００の内腔は、流路３１１を介して流出入口５１１（ハウジング５１の内部）に連通する。

【００４６】ノズル装着部３１の下端側の部分は、下方

向に向かって外径が漸減するテーパ状になっている。このテーパ状の部分がノズル３００の基端開口３０１内に隙間なく挿入し嵌合することにより、ノズル３００がノズル装着部３１に対し着脱自在に気密的に固定される。ノズル３００は、好ましくは、例えば各種樹脂材料等で構成されており、ディスポーザブル（使い捨て）となっている。

【００４７】異なる液体を分注する際には、ノズル３００を交換することによりコンタミネーションを防止することができる。ノズル３００の交換は、分注ヘッド３をノズル収納部２４に移動させ、図示しないノズル交換機構により自動的に行うことができるようになっているのが好ましい。

【００４８】なお、本発明では、図示のような構成に限らず、ノズル装着部３１に対しノズル３００が例えば螺合により着脱自在に装着されるものであってもよく、ノズル３００が分注ヘッド３に対し着脱できないようなものであってもよい。

【００４９】図１に示すように、分注ヘッド移動手段４は、以上説明したような分注ヘッド３を鉛直方向（Ｚ軸方向）に移動可能に支持する昇降機構４１と、昇降機構４１を水平方向（Ｙ軸方向）に移動するＹ軸方向移動機構４２と、Ｙ軸方向移動機構４２をＹ軸に垂直な水平方向（Ｘ軸方向）に移動するＸ軸方向移動機構４３とを有している。このような構成により、分注ヘッド移動手段４は、分注ヘッド３をステージ２１上で３次元方向に移動させることができるようになっている。

【００５０】分注ヘッド移動手段４の作動は、記憶部１８に格納された分注ヘッド移動手段４を制御するためのアプリケーションプログラムや、入力部１９から入力された入力データに基づいて、制御部１１により制御される。

【００５１】なお、昇降機構４１、Ｙ軸方向移動機構４２およびＸ軸方向移動機構４３は、いかなる構造の機構でもよく、例えば、送りねじ、ラック＆ピニオンギア、サーボモータ、流体圧シリンダなどを利用した任意の機構とすることができる。

【００５２】このような分注装置１は、分注ヘッド移動手段４の作動により分注ヘッド３を各試薬容器１００と、各反応容器２００との間で移動しながら、液体５００の仕分け、希釈、混合および滴下などの分注作業を行う。

【００５３】以下、分注装置１の作動を、試薬容器１００中の液体５００を反応容器２００に仕分けする場合を例に説明する。

【００５４】［１］　まず、ノズル３００の先端開口３０２が空中にある状態で、すべての通電部５３に所定の電圧で通電する。これにより、すべての体積可変部材５２は、体積が増大した状態になる。

【００５５】［２］　次いで、分注ヘッド移動手段４を作動し、ノズル３００の先端開口３０２が試薬容器１００中の液体５００の液面より下に位置するように分注ヘッド３を移動する。

【００５６】［３］　この状態で、通電部５３に対する通電を解除すると、体積可変部材５２の体積が減少することにより、ノズル３００内の空気が流出入口５１１からハウジング５１内に吸入され、ノズル３００内の圧力が低下する。この圧力低下により、液体５００が先端開口３０２よりノズル３００内に吸入される（図２参照）。

【００５７】このとき、通電を解除する通電部５３の個数を調整することにより、ノズル３００内に吸入する液体５００の量を調整することができる。すなわち、通電を解除する通電部５３の個数が１個の場合には、１個の体積可変部材５２の体積減少量に対応した量の液体５００がノズル３００内に吸入される。そして、通電を解除する通電部５３の個数を２個、３個、・・・、１４個とすることにより、液体５００の吸入量は、１個の通電部５３の通電を解除したときに対し概ねその２、３、・・・、１４倍となる。このようにして、液体５００の吸入量を１４段階に調整することができる。

【００５８】また、このとき、体積可変部材５２が印加電圧をゼロにしても体積が完全には元の大きさ（基準の大きさ）に戻らないような性質のものである場合、すなわち、体積可変部材５２の体積変化にヒステリシスがあるようなものである場合には、通電部５３に対する通電を解除した後、体積可変部材５２の体積が基準の大きさに戻るように、通電部５３に逆方向の電圧を印加するような制御を行うこととしてもよい。また、前記［１］の前に、通電部５３にある一定の基準電圧を印加しておき、［１］でこれより高い電圧を通電部５３に印加し、［３］で通電部５３への印加電圧を前記基準電圧に戻す、というような制御をしてもよく、この制御によりヒステリシスの影響を小さくすることができる。これらのような制御を行うことにより、より精度の高い分注を行うことができる。本明細書中では、上記のように、通電部５３に対する通電を解除した後に逆方向の電圧を印加する場合や、通電部５３への印加電圧をある一定の基準電圧に戻す場合も含めて、単に「通電の解除」と言う。

【００５９】このような液体５００の吸入動作において、複数個の通電部５３に対する通電を解除する場合、それらの通電部５３に対する通電を同時に解除すると、液体５００を高速に吸入することができる。

【００６０】また、複数個の通電部５３に対する通電を解除する場合、各通電部５３に対し時間差をおいて通電を解除してもよい。この場合、その時間差を調整することにより、液体５００の吸入速度を調整することができる。すなわち、その時間差を長くすると、吸入速度を遅くすることができ、その時間差を短くすると、吸入速度を速くすることができる。

【００６１】［４］　ノズル３００内に液体５００を吸入したら、分注ヘッド移動手段４を作動し、分注ヘッド３を反応容器２００の位置に移動する。
【００６２】［５］　次いで、通電を解除した通電部５３に対し、再度、所定の電圧で通電する。これにより、通電された体積可変部材５２の体積が増大し、ハウジング５１内の空気が流出入口５１１から流出してノズル３００内の圧力が増大する。この圧力増大により、ノズル３００内の液体５００が先端開口３０２より吐出（排出）される。この吐出された液体５００を反応容器２００に滴下（落下）させることにより、反応容器２００中に付与する。また、吐出された液体５００が先端開口３０２付近に付着した状態になる場合には、分注ヘッド移動手段４を作動してノズル３００の先端部を反応容器２００の内壁またはその中の液体に接触させることより、吐出した液体５００を反応容器２００中に付与することとしてもよい。
【００６３】このような液体５００の吐出動作の際には、前記の吸入動作のときと同様に、通電する通電部５３の個数を調整することにより、吐出する液体５００の量を調整することができる。
【００６４】また、このような液体５００の吐出動作において複数個の通電部５３に通電する場合、それらの通電部５３に対し同時に通電すると、液体５００を高速に吐出することができる。また、吐出量や、先端開口３０２の開口径等の条件によっては、液体５００をノズル３００から噴射するようにして吐出することもできる。
【００６５】また、液体５００の吐出動作において複数個の通電部５３に通電する場合、各通電部５３に対し時間差をおいて通電してもよい。この場合、その時間差を調整することにより、液体５００の吐出速度を調整することができる。すなわち、その時間差を長くすると、吐出速度を遅くすることができ、その時間差を短くすると、吐出速度を速くすることができる。
【００６６】［６］　分注ヘッド３を他の反応容器２００に移動して［５］の動作を繰り返すことにより、試薬容器１００中の液体５００を各反応容器２００に仕分けすることができる。
【００６７】このように、本発明のポンプ５は、体積可変部材５２の体積変化によって流体を吸入、吐出するものであり、機械的な可動部がない。よって、機械的ガタ、バックラッシュなどの悪影響を受けないので、吸入量、吐出量を高い精度で制御（調整）することができる。特に、極めて微量の流体でも高い精度で吸入、吐出することができる。また、構造が簡単で、製造コストの低減にも寄与する。また、可動部がないことから、故障のおそれが少なく、耐久性にも優れる。
【００６８】また、このようなポンプ５（ポンプ装置６）を備えた本発明の分注ヘッド３および分注装置１では、分注量を高い精度で制御（調整）することができ、特に、極めて微量の液体でも高い精度で分注することができる。
【００６９】さらに、本実施形態では、複数個の体積可変部材５２に対しそれぞれ個別に通電部５３が設けられており、各体積可変部材５２に対しそれぞれ独立して電圧を印加可能になっていることにより、吸入量、吐出量を容易かつ高精度に調整することができる。なお、本発明では、体積可変部材５２を複数個設ける場合、その数は、特に限定されず、例えば２～１０００個程度とすることができる。体積可変部材５２の個数を多くすることにより、吸入量、吐出量を微量から比較的多い量までより広範囲で高精度に調整することができる。
【００７０】なお、本発明では、体積可変部材５２の設置個数が１個で、吸入量、吐出量が所定の値に定まっているようなものでもよい。また、体積可変部材５２が１個の場合でも、通電部５３への通電電圧を調整することにより、体積可変部材５２の体積変化量を調整することができ、これにより、吸入量、吐出量を調整することもできる。
【００７１】また、複数の体積可変部材５２が設置されている場合にも、通電部５３への通電電圧を調整するようにしてもよい。これにより、吸入量、吐出量をより多段階に精度良く調整することができる。
【００７２】また、本発明では、体積可変部材５２は、上述した実施形態と逆に、電圧の印加により体積が減少するようなものであってもよい。
【００７３】また、本実施形態では、空気（気体）を作動流体として吸入・吐出することにより目的の液体５００を分注するものであったが、本発明では、作動流体は、絶縁性の液体でもよい。すなわち、ハウジング５１内に絶縁性液体が充填され、流出入口５１１より吸入・吐出する絶縁性液体を介して液体５００を分注するものでもよい。また、体積可変部材５２および通電部５３の表面に絶縁性の被膜を形成したような場合には、作動流体は、絶縁性のない液体でもよい。
【００７４】また、本発明では、体積可変部材は、磁場の印加によって（磁歪効果により）体積が変化する物質で構成されたものであってもよい。このような物質としては、特に限定されないが、例えば、Ｔｂ－Ｄｙ－Ｆｅ合金等の各種磁歪材料、超磁歪材料等が挙げられる。この場合、通電部としては、例えば、通電によりこの体積可変部材に磁場を印加するコイルを用いることができる。
【００７５】図５は、本発明の分注ヘッドアレイの実施形態を示す斜視図である。以下、この図を参照して本発明の分注ヘッドアレイの実施形態について説明するが、前述した実施形態との相違点を中心に説明し、同様の事項はその説明を省略する。
【００７６】図５に示す分注ヘッドアレイ７は、複数個（図示の構成では、１６個）の分注ヘッド７１を並設し

てなるものである。分注ヘッド７１は、その形状が異なること以外は、前記分注ヘッド３と同様である。

【００７７】分注ヘッド７１におけるポンプのハウジング７１１は、扁平な直方体状をなしている。ハウジング７１１内には、複数（多数）の細長い板状の体積可変部材が重ねて配置されている。

【００７８】分注ヘッドアレイ７は、このような薄型の分注ヘッド７１を複数個その厚さ方向に一列に並設してなるものである。本発明のポンプは、機械的な駆動源が不要な簡単な構造であることから、形状の自由度が高い。よって、このような薄型の分注ヘッド７１や、配列ピッチの小さい分注ヘッドアレイ７を容易に実現することができる。

【００７９】このような分注ヘッドアレイ７を備えた分注装置によれば、複数箇所に対して一度に分注を行うことができ、例えば、行列状に多数の穴が形成されたマイクロプレート（多穴プレート）に分注を行う際などに、極めて高い効率で迅速に分注を行うことができる。

【００８０】図６は、本発明のポンプの他の実施形態を示す縦断面図である。以下、この図を参照して本発明のポンプの他の実施形態について説明するが、前述した実施形態との相違点を中心に説明し、同様の事項はその説明を省略する。

【００８１】本実施形態のポンプ５’は、図６中の左側から右側に向かって流体を送出するものである。このポンプ５’は、分注装置に限らず、流体を送出する他の各種の装置に適用することができる。

【００８２】ポンプ５’は、前記ポンプ５とほぼ同様の構成になっており、ハウジング５１’と、ハウジング５１’内に設置された複数の体積可変部材５２と、通電により体積可変部材５２に電圧を印加する通電部５３とを有している。

【００８３】ハウジング５１’には、流体が流入する流入口５１２と、流体が流出する流出口５１３とがそれぞれ設けられている。すなわち、本実施形態では、ハウジング５１’に流入口５１２と流出口５１３とが別個に形成されている。流入口５１２に接続された流路１４の途中には、逆止弁（逆流防止弁）１６が設けられており、流出口５１３に接続された流路１５の途中には、逆止弁（逆流防止弁）１７が設けられている。

【００８４】ポンプ５’が前記と同様にして作動すると、ポンプ５’は、流入口５１２より流体を吸入し、流出口５１３より流体を吐出する。これにより、流路１４および１５中の流体を図６中の右方向に送出することができる。

【００８５】すなわち、前記ポンプ５は、作動流体である空気（気体）を介して目的の液体５００を吸入・吐出するものであったが、本実施形態のポンプ５’は、目的の流体を直接に吸入・吐出し、送出するものである。

【００８６】ポンプ５’が送出する流体としては、液体でも気体でもよい。なお、液体の場合には、体積可変部材５２および通電部５３の表面に絶縁性の被膜が形成されているのが好ましい。

【００８７】また、逆止弁１６および１７は、なくてもよいが、逆止弁１６および１７の少なくとも一方が設けられているのが好ましい。

【００８８】以上、本発明のポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を図示の実施形態について説明したが、本発明は、これに限定されるものではなく、ポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を構成する各部は、同様の機能を発揮し得る任意の構成のものと置換することができる。また、任意の構成物が付加されていてもよい。

【００８９】また、本発明は、１回の吸入／吐出量が比較的多いものから微量なものまで適用することができるが、特に、１回の吸入／吐出量が１ナノリットル～１００マイクロリットル程度の微量なものに好適である。

【００９０】また、体積可変部材は、板状のものに限らず、棒状、ブロック状など、いかなる形状のものでもよい。また、電圧または磁場を印加されたときの体積可変部材の変形態様もいかなるものでもよい。

【００９１】

【発明の効果】以上述べたように、本発明によれば、流体を高い精度で吸入・吐出することができ、特に、微量の流体でも高い精度で吸入・吐出することができる。

【００９２】また、簡単な構造で上記効果を達成することができ、製造コストの低減にも寄与する。また、故障のおそれが少なく、耐久性にも優れる。また、流体を高速に吸入・吐出することができる。

【図面の簡単な説明】

【図１】本発明の分注装置の実施形態を示す斜視図である。

【図２】図１に示す分注装置における分注ヘッドおよびノズルを示す縦断面図である。

【図３】図２に示す分注ヘッドにおける体積可変部材を示す斜視図である。

【図４】図１に示す分注装置のブロック図である。

【図５】本発明の分注ヘッドアレイの実施形態を示す斜視図である。

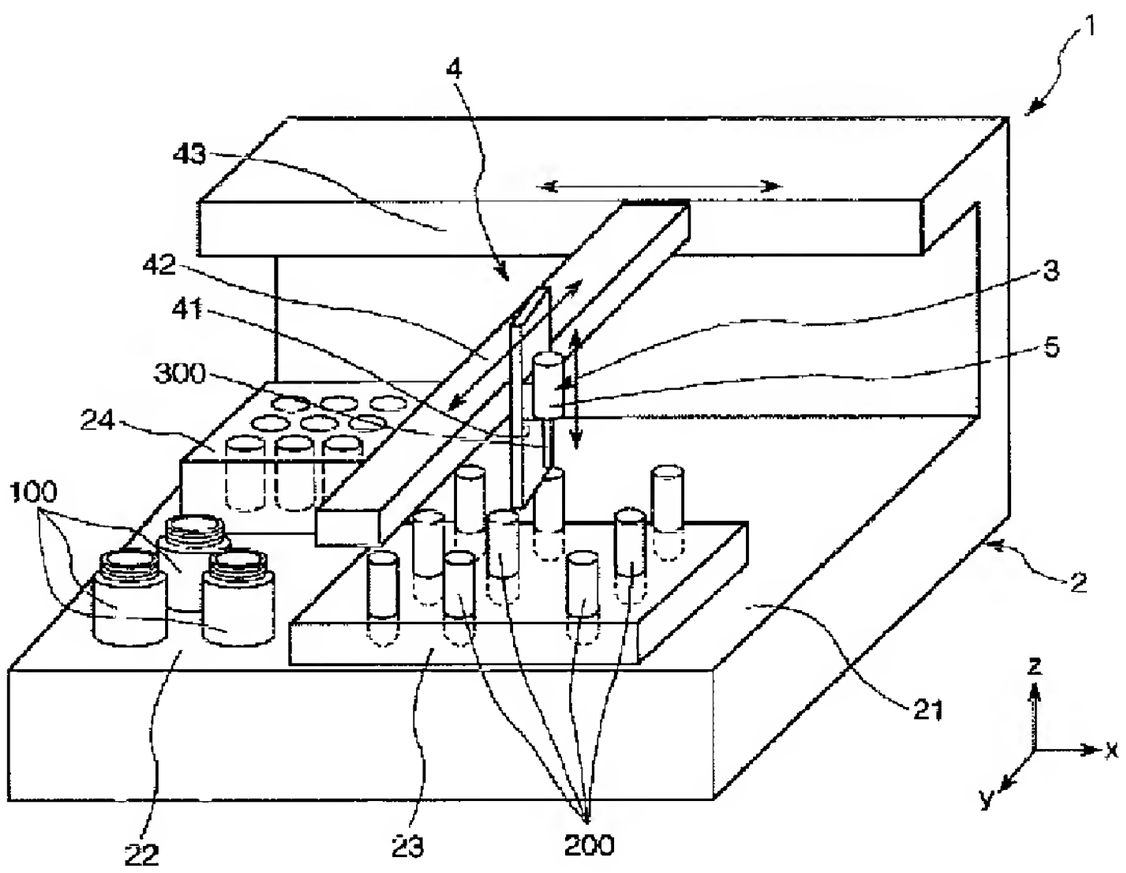
【図６】本発明のポンプの他の実施形態を示す縦断面図である。

【符号の説明】

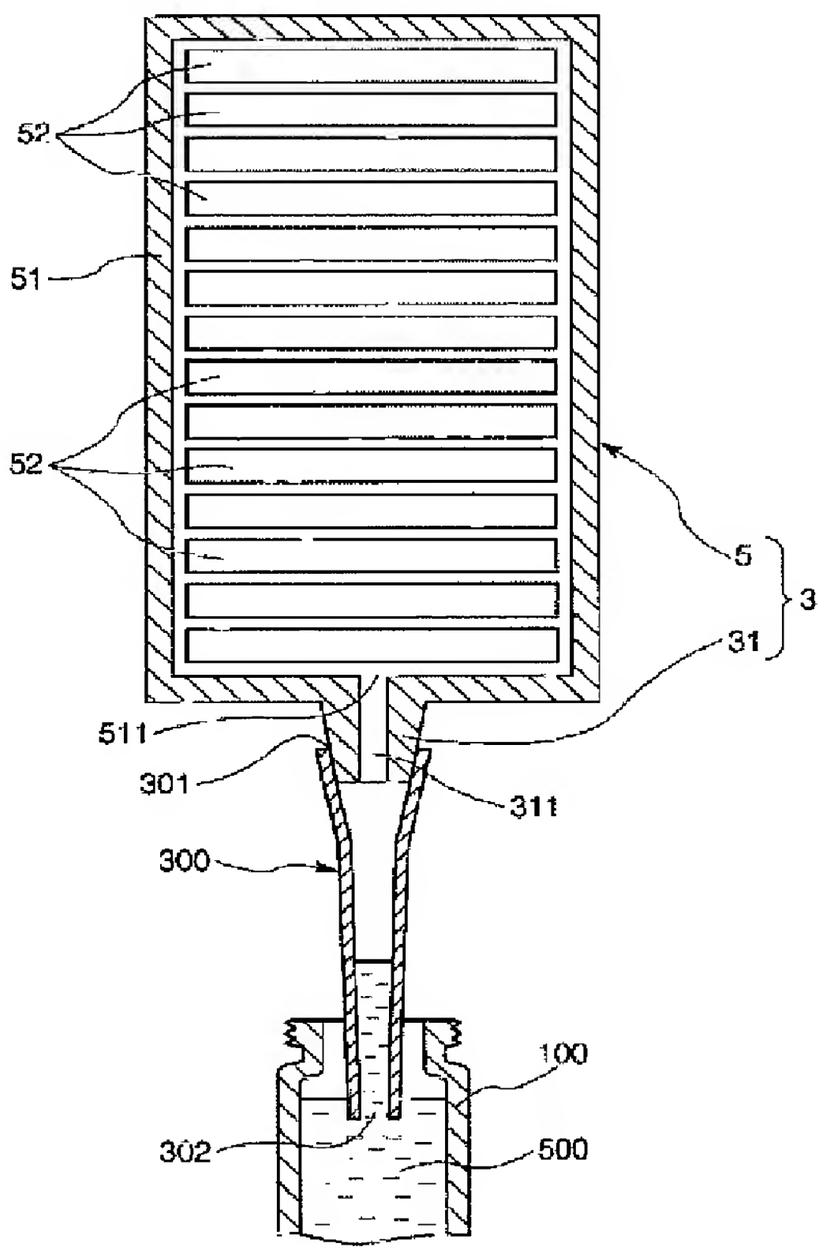
１	分注装置
２	装置本体
２１	ステージ
２２	試薬容器収納部
２３	反応容器収納部
２４	ノズル収納部
３	分注ヘッド
３１	ノズル装着部

311	流路
4	分注ヘッド移動手段
41	昇降機構
42	Y軸方向移動機構
43	X軸方向移動機構
5、5'	ポンプ
51、51'	ハウジング
511	流出入口
512	流入口
513	流出口
52	体積可変部材
53	通電部
531、532	電極
533	リード線
6	ポンプ装置
7	分注ヘッドアレイ
71	分注ヘッド
711	ハウジング
11	制御部
12	ポンプ駆動回路
13	ポンプ制御手段
14、15	流路
16、17	逆止弁
18	記憶部
19	入力部
100	試薬容器
200	反応容器
300	ノズル
301	基端開口
302	先端開口
500	液体

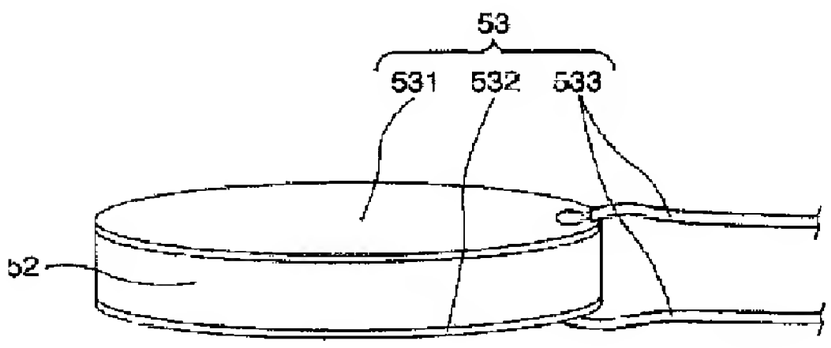
【図1】



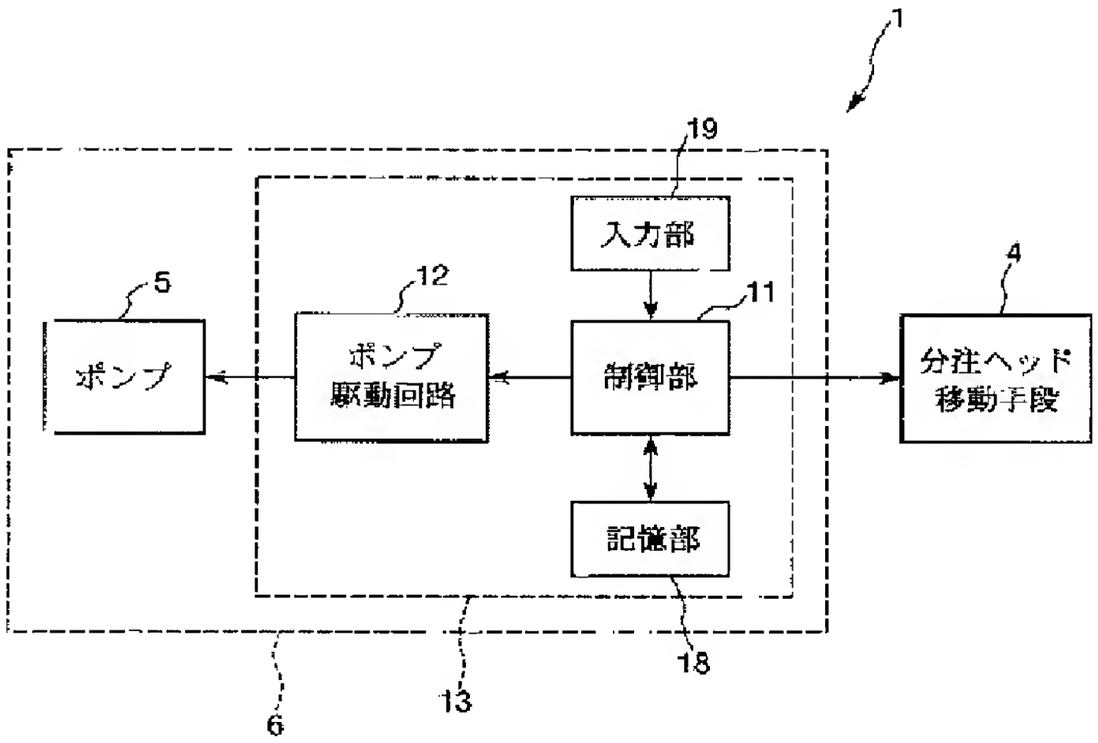
【図2】



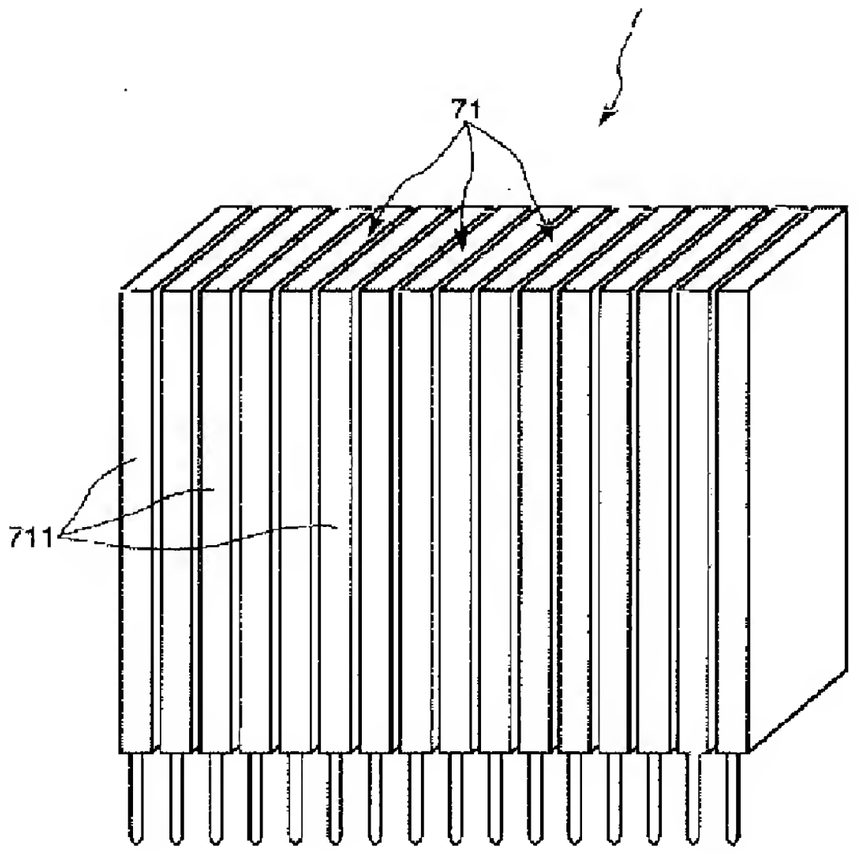
【図3】



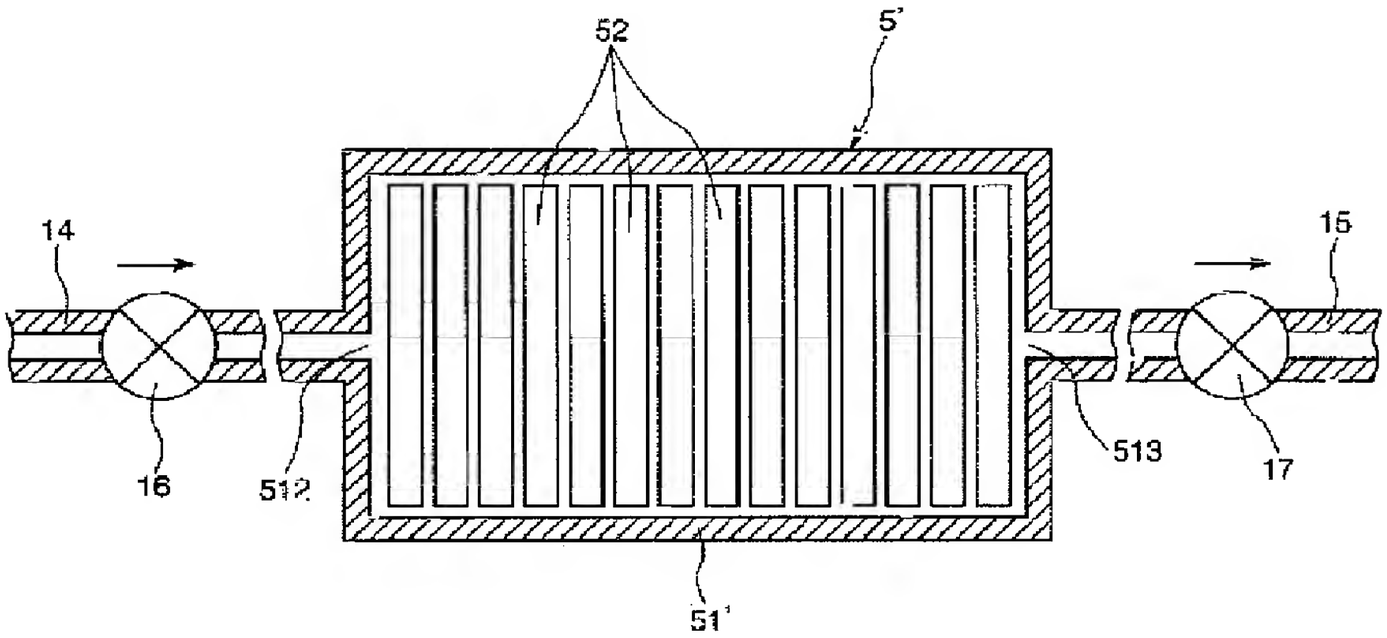
【図4】



【図5】



【図6】



フロントページの続き

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